

COULD THE UNITED STATES AFFORD TO LOSE A MAJOR PORT?

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MASTER OF MILITARY ART AND SCIENCE
Homeland Security Studies

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ABSTRACT

COULD THE UNITED STATES AFFORD TO LOSE A MAJOR PORT? by LCDR Daniel W. Landi, 75 pages.

What what would happen if this took place in New York Harbor? Looking at the different classes of ships that would be needed and if it is a terrorist act or simply poor seaman ship. In addition, how would the nation respond to the closure of the port as well as the economic impact? The nation had salvage response and how long it would take and cost. The cost would range in the hundreds of millions and require a two-step approach. The nation would need to start salvage operations and to start dredging.

An event that would force the closure of one of the United States busiest ports would require a swift response to ensure that the flow of commerce would continue.

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ACRONYMS

AMS	Area Maritime Security
BLEVE	Boiling-Liquid Expanding-Vapor-Explosion
CBP	United States Customs and Border Protection
CDC	Certain Dangerous Cargos
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COTP	Captain of the Port
DHS	Department of Homeland Security
DoS	Department of State
DoT	Department of Transportation
EIA	United States Energy Information Administration
EP&R	Emergency Preparedness and Response
EPA	Environmental Protection Agency
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FMSC	Federal Maritime Security Coordinator
FOSC	Federal On-Scene Coordinator
GMDSS	Global Maritime Distress and Safety System
I&A	Office of Intelligence and Analysis
LNG	Liquefied Natural Gas
MARAD	Maritime Administration
MBARI	Monterey Bay Aquarium Research Institute
OSLTF	Oil Spill Liability Trust Fund

PFO	Principal Federal Official
RPG	Rocket-Propelled-Grenade
SupSalv	Supervisor of Salvage and Diving
TEU	Twenty-Foot Equivalent Units
TRIA	Terrorism Risk Insurance Act
TSA	Transportation Security Administration
ULCC	Ultra Large Crude Carrier
ULCV	Ultra Large Container Vessel
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard

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CHAPTER 1

INTRODUCTION

Overview

It is the policy of the United States to take all necessary and appropriate actions, consistent with U.S. law, treaties and other international agreements to which the United States is a party, and customary international law as determined for the United States by the President, to enhance the security of and protect U.S. interests in the Maritime Domain.

— Homeland Security Presidential Directive 13,
Maritime Security Policy

Water covers more than two thirds of the world. Over 90 percent of the world's cargo is transported over the ocean. New York City's harbor is the third largest in the United States and the largest on the east coast. In 2010, the Port of New York and New Jersey handled 5.3 million loaded and unloaded twenty-foot equivalent units (TEUs), a 16percent increase in total container traffic from 2009. Loaded containerized cargo volumes rose 12.6 percent, led by continued growth in trade with Asia and North Europe. The dollar value of all cargo that moved through the port exceeded \$175 billion a year or \$480 million per day.¹

The loss of a key port on the east coast would cost billions of dollars in lost revenue to the surrounding area. The impact would not just affect the businesses but the people as well from the ability not to be able to put fuel in the car or to put food on the table. Some of these effects were seen recently when hurricane Sandy struck the east coast of the United States. People would wait in line for hours with the hope they would

¹The Port Authority of New York and New Jersey, "About the Port," <http://www.panynj.gov/port/about-port.html> (accessed 11 June 2013).

be able to get their gas ration. Supermarkets were stripped bare of all goods. Businesses did not reopen for a week after the storm hit. The ripple effect of the channel blocked would not just affect the greater New York area but the entire east coast and beyond.

Primary Research Question

What is the response to a vessel of 70,000 tons or larger ship sinking at and the only way for large ships to enter the harbor, the mouth of the channel into New York City?

Secondary Research Questions

1. What size ship is needed to sink in the channel to would block it?
2. What type of security is on merchant ships?
3. Can it be issue be handled by Department of Homeland Security (DHS) needed to assist?
4. What capabilities does DHS have to address the issue?
5. What would be the likely impact to the economy?
6. What would be the likely impact to the surrounding ports?
7. How will DHS be able to clear the harbor before long term effects take root?
8. What is currently being done to prevent this from happening?

Assumptions

The following assumptions are believed to remain true, and add relevance to the research project. The following research has shown that an incident of this level has not taken place in recent history of New York Harbor. The depth of the harbor and channel

will remain constant barring any major natural disaster. Currently there is no response for this type of event.

Definitions

Panamax: A vessel that cannot be longer than 294, 13 m (965 ft), wider than 32, 31 m (106 ft) and her draught cannot be more than 12, 04 m (39.5 ft).

Post Panamax: The Post Panamax has been created as a result of the expanding plans for Panama Canal locks. Expanded locks will be around 427 m (1400 ft) long, 55 m (180 ft) wide and 18, 30 m (60 ft) deep so Panama Canal will be able to handle larger vessels.²

VLCC and ULCC: VLCC stands for Very Large Crude Carriers. They have a size ranging between 180,000 to 320,000 DWT. They are very flexible in using terminals and can operate in ports with depth limitations. VLCCs are used extensively around the North Sea, Mediterranean and West Africa. ULCC or Ultra Large Crude Carriers are the largest shipping vessels in the world with a size more than 320,000 DWT. Called Super Tankers, ULCCs are used for long-haul oil crude transportation from Middle East to Europe, Asia, and North America.³

Limitations

The major constraint is that not every sinking in New York City harbor has been recorded. Other limitations are the area of some of the sinkings; some took place while

²Marine Connector, "Ship Sizes," <http://maritime-connector.com/wiki/ship-sizes/> (accessed 11 June 2013).

³Ibid.

the ship was moored to the pier while others were in remote regions of the harbor and these would not have an impact on harbor transit. The area of the harbor that will focus on will be the channel due to the depth of the harbor. The channel is greater than forty feet deep to accommodate merchant traffic the rest of the harbor is thirty feet or less in depth. Another constraint is the scope of the project. This study will focus on the major waterways of the east coast of the United States, more specifically the channel leading into New York Harbor.

The focus of the study will be on mechanical, engineering, weather, and limited terrorist attacks on the merchant fleet. The threat of a terrorist attack has been covered in other projects. The security measures that are in place on board merchant ships and the security measures in place in the ports of the United States will be covered briefly.

Current data from the United States Coast Guard on the above-mentioned topic is not available at this time or is currently classified. This data would have been important to the research because it would have shown whether there is currently a plan in place for this type of event or it has been overlooked. The data would have been used to compare response times and preventive measures that are in place. The information would have been part of a case study comparing it with the collapsed bridge in Minnesota.

Significance of Study

By studying this area, local agencies may be able to enhance and improve on response times or even prevent this type of incident from occurring. If this type of accident took place, is there another way for merchant traffic to get into New York harbor? Alternatively, would widening the restrictive points in the channel be a more realistic option? If this issue is a possibility in New York harbor what about harbors such

as Baltimore harbor or the entrance to Chesapeake Bay? Do the ports have the assets in place to start a salvage operation of this scale in place and are they capable of building temporary port?

Conclusion

This study will attempt to describe the likely impact of a large container vessel sinking in the channel of New York City and define what the implications of such an event would be for New York City and the surrounding area, the response of the United States Coast Guard and Department of Homeland Security as well as the effects on the economy.

This study will briefly address the threat of terrorist attacks on the merchant fleet and the security measures put in place to prevent the merchant fleet from becoming an easy target for terrorists. The following factors will be taken into account: who will respond to the sinking and sinking impacts, assessing the meaning of a terrorist attack or a mechanical and engineering failure.

The impact would be serious to the surrounding area and the effects would not just affect the economy in the sense of money but in goods as well. Merchants and business would not be the only ones effected the everyday citizen would be as well. Most of the oil and fuel that supports the tri-state area is received via the port with that said a major loss of fuel and oil would bring the local economy to a halt.

CHAPTER 2

LITERATURE REVIEW

This chapter is broken down into four parts using the four primary sources for the thesis. For each source, a brief understanding will be given of what was uncovered in the research. The four primary sources are as follows: The first source used was “The Terrorist Threat to Liquefied Natural Gas: Fact or Fiction” by LCDR Cindy Hurst for the Institute for the Analysis of Global Security in February 2008. LCDR Hurst discusses if using a LNG tank as a weapon of mass destruction is a credible threat. She discusses why it is not as likely as a person would think. The next source used is “The Effects of Terrorism on Global Capital Markets” by Andrew H. Chenand and Thomas F. Siems in *The Economic Analysis of Terrorism* edited by Tilman Bruck. Here the author looks at the economic impact of terrorism on the world markets and what impact it has. He discusses that terrorism does have an impact but it is not as significant as you might think and continues about the resiliency of the United States markets. The third source is *Port and Maritime Security: Background and Issues* by John F. Frittelli, Martin R. Lee, Jonathan Medalia, Ronald O’Rourke and Raphael Perl. This source looked into port and maritime security and what security was before September 11, 2001 and how it changed after the attack of September 11, 2001. The final primary source is *Marine Salvage Capabilities Responding to Terrorist Attacks in U.S. Ports- Actions to Improve Readiness for Transportation Research Board*. Here the board looks at the marine salvage capabilities of the United States and if the nation can respond to major salvage incident. This insight was very important because it allows for an evaluation of our nations salvage capabilities. The following pages will review each of the sources in more depth.

“The Terrorist Threat to Liquefied Natural Gas: Fact or Fiction,” by LCDR Cindy Hurst for the Institute for the Analysis of Global Security in February 2008 by LCDR Hurst looks into the possible threat from LNG tankers. The theory is a LNG tanker is hijacked by terrorists and used as a weapon against western nations or their allies. This was done in response to the al-Qaeda issuing orders to all militants to attack all natural gas resources around the world. Al-Qaeda understood that the west’s LNG requirements would continue to grow as time passes. The study also takes into account what the blast radius and hazards areas would be the experts varied in the ranges. The ranges described are from 1 mile to 1.3miles.⁴ This range difference could mean the difference between affecting few hundred people or thousands.

The next part of the study describes the techniques that al-Qaeda would use to achieve their goals. Al-Qaeda like any military organization had not only a land component but a maritime one as well. Maritime terrorism is a core component of al-Qaeda’s strategy to achieving their goals. The techniques that al-Qaeda would use include small boats filled with explosives (a USS Cole style attack), rocket-propelled grenades, fire rockets and limpet mines that would convert an LNG tanker into a floating giant bomb. All based off naval manuals describing how to turn LNG tankers into floating bombs.⁵

⁴Government Accountability Office, *Maritime Security: Public Safety Consequences of a Terrorist Attack on a Tanker Carrying Liquefied Natural Gas Need Clarification* (Washington, DC: Government Accountability Office, February 2007).

⁵Ed Blanche, “Tanker Terror: Gulf’s Oil Routes Under Threat,” Jihad Watch, 22 April 2004, <http://www.jihadwatch.org/archives/001677.php> (accessed 26 April 2007).

A Rand study conducted in 2007 entitled *Exploring Terrorist Targeting and Preferences*, noted that hard targets were considered to represent the United States due to security measure that have been put in place. The Rand study looked at 14 attacks and noted that three of the attacks were hard targets. By striking these hard targets, al-Qaeda was able to build credibility among its followers. Under this notion, LNG terminals were considered very hard targets.⁶ The terminals were classified that way based on the security protocols that were put in place. Both al-Qaeda and the United States understood the importance of LNG terminals and tankers.

The next area the paper focuses is on the vulnerabilities of not just the ships and terminals but the LNG industry as a whole. From an engineering standpoint the ships' terminals are a sound design. The vulnerability in the industry comes from the people who are employed by it. The United States has a robust vetting process in place but not all the other nations are as thorough. This is because most LNG comes from nations that are not as secure as the United States or simply do not want to spend the money to conduct these checks. The only personnel that receive these checks are United States citizens and those checks are conducted by the TSA (Transportation Security Administration) and the USCG (United States Coast Guard). The next area that is discussed is the LNG itself. What would it take to detonate the LNG and is it possible? The scenario used is that terrorists hijack a LNG tanker and are able to cause the gas to explode. To counter the point the author explains that for a terrorist to cause the boiling-

⁶Martin C. Libicki, Peter Chalk, and Melanie Sisson, *Exploring Terrorist Targeting Preferences* (Santa Monica, CA: Rand Corporation, 2007), 63.

liquid expanding-vapor-explosion (BLEVE) to flash the terrorist would need to bypass all the mechanical fail safes that are in place.

Ships and the need to crew them also come into question. It took nearly 40 years to build a fleet of two hundred ships, it will only take four years to build another one hundred ships. The issue that became known was the crews needed to operate these ships. With the rapid growth of the LNG shipping crews with experience are ever in demand. The issue is crews with steam turbine experience are in short supply because those with experiences are retiring soon.⁷ What the author does not address is whether there is a school or mentorship program in place to compensate. Next is the flag of the ships. Up until 2001, most all LNG tankers were United States flagged; from 2001 to the present, there were very few that are United States flagged. The United States requires ships with United States flag to employ Americans, which requires higher pay, taxes, fees, and very strict operating regulations. For economic reasons companies register with nations that have a flag of convenience. This means shipping companies can register within a few days with very little restrictions.

The economic aspect of LNG as a target for terrorists is a concern for the United States. In 2006, the United States used over 60 billion cubic feet of natural gas per day.⁸ Since 2006, the natural gas usage in the United States has increased. If the flow of LNG can be disrupted by a terrorist group, it would have a dire impact on the United States.

⁷“Serious LNG Crew Shortage Looms,” *Oil and Gas Journal*, 4 April 2005, http://www.ogj.com/display_article/224811/94/ARCHI/none/none/Qatar,-India,-Egypt-advance-plans;-US-gulfterminals-break-ground/ (accessed 13 May 2007).

⁸“North America LNG Import Terminals,” *Natural Gas Intelligence*, March 2006, <http://intelligencepress.com/features/lng/> (accessed 6 March 2007).

The author points out that there have been multiple LNG explosions but none involving LNG tankers. The explosions all took place on either the natural gas pipeline or at the terminal. The disruption of gas showed little impact on service. The companies were able to shift to other means to transport the gas to their consumers.

An area that the author does not address is whether an LNG tanker could be destroyed or detonated by small arms fire or a Rocket-propelled-grenade (RPG). Data based on recent attacks on LNG tankers off the Somali coast categorically show that this is not plausible. LNG tankers are built to hold the high pressure and temperature (-160 degrees centigrade) at which the LNG is stored.⁹ Additionally, the ignition temperature for natural gas is about 648 degrees C (1,200 degrees F), which is higher than the temperature of an explosion from an RPG.

The author concludes that LNG is an extremely safe energy source with a very safe history. The safety measures on LNG ships as well as building terminals offshore, have helped mitigate the safety concerns of political leaders and international agencies. The article ends by quoting Captain Scott Conway, who argues that LNG tankers are the safest tankers in the shipping industry. “There’s no way I’d bring my wife or child on an oil tanker, for example. However, we did not hesitate to bring our families on the LNG ships. That is how safe the ships were. They’re very well made.” After witnessing various experiments done on LNG and working closely with the liquid, Conway also views it as “an extremely safe, non-toxic, non-explosive cargo.”

⁹Rory Lamrock, AKE Security, “LNG-specific piracy risks: Myths and realities,” Energy Global, 25 November 2011, http://www.energyglobal.com/news/drilling-and-production/articles/LNG-specific_piracy_risks_myths_and_realities.aspx#.UgUppD0o7IU (accessed 20 August 2013).

“The Effects of Terrorism on Global Capital Markets” by Andrew H. Chen and Thomas F. Siems in *The Economic Analysis of Terrorism* edited by Tilman Bruck: For the purpose of this paper, I will use chapters six through 11, this part of the book focuses on the Economic effects of terrorism. The author explains that his paper is not strictly focused on terrorism but also includes military invasions and other unforeseen events that affect the economy. In the scope of this paper, unforeseen events will include the loss of a major port.

The analysis is based off three research questions:

1. Are historical terrorist and military attacks associated with significant negative abnormal returns in U.S. capital markets? If so, to what relative degree?
2. Are recent terrorist and military attacks associated with significant negative abnormal returns in global capital markets?
3. Can the banking/financial sector help minimize crises in capital markets resulting from terrorist and military attacks?

Chapters six through 11 describe how major events impact the economic markets around the world. The research dates from World War I to the present day. In the research, there were three events that had a long lasting (a period of one hundred or more days), impact on the markets. The three events were: the Invasion of France on 12 May 1915, which lasted for 795 days; the attack on Pearl Harbor on 7 December 1941, which lasted for 232 days; and finally, the invasion of Kuwait on 2 August 1990, which lasted for 134 days. Later in the chapter, the author explains the two reasons why the attack on 11 September 2001 did not have a long-term effect. The first reason is that the market of the United

States is so fluid and flexible that it is able to absorb a great deal change. The second reason is the newer and faster communication technology which allowed for a faster response to the change in the markets. With a faster response, the markets are more resilient and in turn harder to disrupt. The United States gross domestic product in 2012 was over 15 trillion dollars.¹⁰ A terrorist organization would need to conduct an attack that would be able to cripple the United States markets. This attack would need to be on the same scale as detonating a nuclear weapon in a major city. In the event of a terrorist attack of the aggression of one nation against another, the markets will be able to rebound. With each event listed above the amount of time needed for the market to rebound shortened, and the ability of a terrorist attack to greatly impact the market and the threat of economic instability became less likely.

Port and Maritime Security: Background and Issues by John F. Frittelli, Martin R. Lee, Jonathan Medalia, Ronald O'Rourke, and Raphael Perl, was originally written in 2004 and updated in 2005. In response to the September 11, 2001 attacks, many analysts have debated the United States port and maritime security. A report from the Interagency Commission on Crime and Security in U.S. Seaports determined that new security measures were needed, and Congress passed the Maritime Transportation Security Act of 2002 (P.L. 107-295) in November 2002.

Many leaders and experts were concerned that shipping could be used to cause harm to the United States. The findings for the report were that, "While commercial aviation remains a possible target, terrorists may turn their attention to other modes.

¹⁰Trading Economics, "United States GDP," <http://www.tradingeconomics.com/united-states/gdp> (accessed 21 August 2013).

Opportunities to do harm are as great, or greater, in maritime and surface transportation. Initiatives to secure shipping containers have just begun.”¹¹ The author explains that the features of the United States Maritime System are broken down into three parts:

1. United States ports
2. Commercial Ships Using U.S. Ports
3. Cargo Containers

The author points out that there are over 300 ports and over 3,700 terminals spread out over United States. Most of the ships that make port calls in the United States are owned by foreign companies. Nearly 6,000 commercial ships made approximately 60,000 U.S. port calls.¹² Cargo containers come in two sizes 8 x 8 x 20 feet or 8 x 8 x 40 feet. Each year, more than six million containers enter the United States, and only about two percent of them are inspected. The United States Customs and Border Protection (CBP) inspections could include scanning the entire container with a sophisticated x-ray or gamma ray machine, unloading the contents of a container, or both.¹³

Ships are the primary mode of transportation for world trade. Ships carry approximately 80 percent of world trade by volume. The United States is the world’s leading maritime trading nation, accounting for nearly 20percent (measured in tons) of the annual world ocean-borne overseas trade. Ships carry more than 95percent of the nation’s non-North American trade by weight and 75

¹¹*The 9/11 Commission Report: Final Report of the National Commission on Terrorist Attacks Upon the United States* (New York, NY: W.W. Norton, 2004), 391.

¹²Department of Transportation, Maritime Administration, *Vessel Calls at U.S. Ports, 2003*, July 2004, <https://www.hsdl.org/?view&did=455399> (accessed 21 September 2013).

¹³For further information on CBP’s container inspection process, see AG Times, “CBP Fact Sheet: The 5 Percent Myth vs. U.S. Customs and Border Protection Reality,” 7 October 2004, <http://agtimes.com/boards/viewtopic.php?t=32630&sid=e136dc9bb0c4548451a11a1d4e44bec8> (accessed 2 August 2013).

percent by value. Trade now accounts for 25 percent of U.S. Gross Domestic Product (GDP), up from 11 percent in 1970.¹⁴

In the matters of maritime law enforcement, the United States Coast Guard (USCG) is the lead federal agency and is supported by the CBP and the Transportation Security Administration (TSA). The author points out that strong security should be balanced. If security is too tight, it will restrict the flow of commerce, in turn causing delays and driving up prices across the board. An example of the new measure is the requirement for the vessels to transmit their manifests 24 hours in advance of off loading their cargo in a United States port.¹⁵

The next chapter describes the need for increased port security at the port from which the ship originates. The thinking is that it is too late to search a ship for terrorists when it is sitting off the U.S. coast. It is better to find security issues while they are still far way. The issue is that there are only a few security systems to scan exporting cargo compared with cargo that is being imported. Another issue is that most foreign nations do not have the resources to improve their own port security.

Chapters 3 and 4 explain the roles of the Department of Homeland Security (DHS) and the USCG. In 2003, the USCG was transferred from the Department of Transportation (DoT) to the DHS. Under the DHS, USCG funding was increased so that

¹⁴John F. Fritelli, *Port and Maritime Security: Background and Issues for Congress*, 27 May 2005, http://webcache.googleusercontent.com/search?q=cache:r_O1ddrEfFAJ:www.fas.org/sgp/crs/homsec/RL31733.pdf+port+and+maritime+security+background+and+issues&cd=1&hl=en&ct=clnk&gl=us (accessed 4 August 2013).

¹⁵Cornell University Law School, 19 CFR, *U.S. Customs And Border Protection, Department Of Homeland Security; Department Of The Treasury*, October 2002, <http://www.law.cornell.edu/cfr/text/19/chapter-I> (accessed 12 May 2013), part 4, 113, 178, 66318.

the USCG would be able to fulfill its expanded role. In the realm of maritime homeland security, the USCG's mission, in conjunction with joint and interagency forces, is to protect the U.S. Maritime Domain and the U.S. Marine Transportation System and deny their use and exploitation by terrorists as a means for attacks on U.S. territory, population and critical infrastructure. The USCG will prepare for and conduct emergency response operations in the event of an attack. When directed, the USCG, as the supported or supporting commander, will conduct military homeland defense operations in its traditional role as a military service.¹⁶

As noted above, the USCG is the lead agency for keeping the ports and waterways safe from all threats. The author begins examining the funding for improved security measures in the ports and waterways. Congress has given the USCG and TSA over a billion dollars to improve security, and another six billion over the next 10 years,¹⁷ but it may not be enough money to cover the cost. Another source of funds would be to increase the import duties that are placed on maritime shippers. Currently, maritime duties generate nearly 15 billion in revenue for the United States.¹⁸ This is just one of the possible ways for the government to generate income to improve port and waterway safety.

¹⁶Department of Transportation, Maritime Administration, 28.

¹⁷Bureau of National Affairs, "Daily Report for Executives," no. 75, April 18, 2003, A-23.

¹⁸Government Accountability Office, GAO-02-1090T, *Marine Transportation, Federal Financing and Infrastructure Investment Framework* (Washington, DC: Government Accountability Office, September 2002).

In the final chapter, the author explores the possibility that a nuclear weapon could be transported to the United States in a cargo container, and investigates what the response would be. He continues by talking about using interagency communication and teamwork to stop the threat before it happens. The issue is that, in the scenario, only two percent of the cargo is being searched and the remainder is subjected to X-ray scans, which are currently used in port security. In addition, he does not address the foreign ports and nations which meet the United States' standards for security while ships are being loaded in port.

Marine Salvage Capabilities Responding to Terrorist Attacks in U.S. Ports-Actions to Improve Readiness for Transportation Research Board was written in response to the capabilities of the United States to respond to a terrorist attack that blocked or denied the use of a harbor or port. The United States Navy Office of the Supervisor of Salvage and Diving (SupSalv) directed the National Academies' Marine Board within the Transportation Research Board convene a workshop of marine transportation and salvage professionals, as well as organizational stakeholders in government and industry.¹⁹ The Navy is the overall responsible party for making sure that there are salvage capabilities on each coast that are able to respond. The issue that came to light is the lack of capabilities and money to pay for equipment from the private sector.

¹⁹U.S. Congress, Report of the Committee for Marine Salvage Response Capability: A Workshop, Conference Proceedings, *Marine Salvage Capabilities Responding to Terrorist Attacks in U.S. Ports-Actions to Improve Readiness for Transportation Research Board*, Washington, DC, 5-6 August 2003, 1.

The paper paints a scenario where two major United States ports that are attacked by terrorists. Each port has a major salvage crisis that requires a ship(s) to be removed. The goal of the scenario was to see how the agencies would respond and what the outcome would be. At the end of the scenario, many discussions were held and four major issues were raised:

1. physical salvage and harbor clearance issues
2. financial, economic, and political issues
3. legal, forensic, and human casualty issues
4. environmental issues

A panel was assigned to work on these four issues and try to arrive at a solution for each one. At the conclusion of the workshop, the two main concerns were the physical and organizational capabilities of the United States. In an attempt to address the four concerns mentioned earlier, the panel discovered some interesting results. On the question of physical salvage and harbor clearance issues, the panel found that since there is not a great need for this level of salvage capabilities in the United States, that the skills and capabilities are diminishing over time. In addition, international salvage companies cannot operate in United States waters with specific waivers from U.S. law. Next the cost of maintaining the salvage equipment was addressed. During an emergency, the U.S. customs can waive the requirement on foreign-flagged vessels. To mobilize salvage equipment from overseas is another issue that came to light. Even if the equipment is available, that does not necessarily mean that the United States will be able to use it. Most of the heavy lift equipment is contracted to major oil companies and not for lease. There are stiff fines in place on these salvage companies which would not make it

profitable to assist the United States. Few contracts have a war or government request clause in them to allow salvage companies to assist. The next concern voiced is the question of how long it would take to clear a channel and allow access to the port. The panel addressed this in the following quote:

the group estimated that dredging to open another channel in Houston, where barge channels are already available outside the main channel, may take only 24 hours once equipment is ready. Furthermore, if a broadside collision results in vessels remaining upright in relatively shallow water and without extensive damage, patch-and-float operations can typically be carried out in two or three weeks. When vessels cannot be patched and floated, cutting and removal may take two to three months, possibly longer.²⁰

In this timeline, the issues of weather and the current are not addressed. How would you plan for hurricanes and storms in the region? The panel noted that dredging a new channel might be the fastest way to open up the channel for barges, but what about larger ships? There is not an unlimited number of barges. If larger ships are not able to pull in, what port(s) would they head to? Next, the financial issues associated with this operation will be addressed.

The sinking of the ship in this scenario is based on a terrorist attack and was not on poor seamanship. Under normal conditions the Oil Spill Liability Trust Fund (OSLTF) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is used when there is threat of pollution. If a federal disaster declaration is made, Federal Emergency Management Agency (FEMA) will be used. If it is a maritime incident, the U.S. Captain of the Port can respond. In the case of a terrorist attack, no agency has yet been named to pay for the services required. After September 11, 2001 attacks, the Terrorism Risk Insurance Act (TRIA) allowed for companies to buy

²⁰Ibid., 22.

insurance to cover terrorist acts. Under the current law, if an attack took place a Principal Federal Official (PFO) or Federal On-Scene Coordinator (FOSC) is designated by the Initial National Response Plan to allocate funds to allow maritime salvage to respond.

While salvage operation is underway, what will the economic impact be? The economic impact is a compound problem in the sense that the longer a port is closed, the great the impact will be. The impact affects other ports that need to absorb the extra shipping traffic, as well as affecting railways and trucks that transport the goods. The report suggests that it might be more cost effective to pay for a speedier ship salvage operation then to offset the cost of the economy. There are also the political issues that come with this type of attack. Normally, the guilty party that caused the accident is liable for paying for the cleanup. In the case of a terrorist attack, that is simply not possible. The next issue for political leaders is how the public views the response of the government and local agencies. Moreover, has the public lost confidence in its leaders to protect and defend them from a threat? Politicians will need to work out the legal, forensic, and human casualty issues.

The legal, forensic, and human casualty issue that came to light in the report was that equipment owners might need contractual protection or protection for damages caused to equipment and personnel moved by the government. In addition, the salvage companies might need legal protection in response to a rapid removal operation from current laws. The report suggested that a salvage representative become a liaison at the DHS. The panel suggests that the Federal Bureau of Investigations (FBI) be part of a

salvage plan that would include awareness at the time of the incident, plan at the time of salvage, and Domestic emergency support plans.²¹

Lastly, the panel addresses the environmental issues. The concern is what impact the event will have on the environment. Is the spill toxic? If so, how does that affect the salvage operation? Who is responsible for the cleanup of the hazardous materials? Will the salvage companies be held responsible if those materials that are more hazardous spread in the process of the salvage operation? With a toxic spill, who is responsible to pay for the cleanup? Are there laws in place to protect the salvage companies and workers from legal issues during the cleanup? Who is paying for the long-term medical care as a result of the toxic material should it be needed?

The environmental concerns play a large part in how the government conducts itself, but in the wake of a major toxic spill, which is more important? Is cleaning up the spill in an environmentally safe way more important than reopening a major port? Alternatively, does the economic issue outweigh the environmental concern, and which of the two is more damaging?

In conclusion, the panel did not arrive at a solution to any of the four issues. On the topic of physical salvage and harbor clearance issues, the panel noted that there was a diminishing skill in the United States and that we do not have enough equipment to conduct a major salvage operation. In response to the financial, economic, and political issues, it is suggested that a lead agency be named, and that standard contract wording is used to allow salvage companies to break their contracts in time of emergency or war. The panel did not have a clear answer on who would pay for the cleanup. In regards to

²¹Ibid., 27.

the legal, forensic, and human casualty issues, they suggested that the FBI and shipping companies have a plan to deal with possible terrorist attacks, and that the salvage companies have a liaison with DHS to advise them on salvage issues. The panel boiled environmental issues down to two main points. What is the impact to the environment? What is more important, a careful cleanup of the environment or the opening the port? Each point has long-term impacts on what would happen in future salvage operations.

The panel did not address what would happen if the port in question was not in a mild weather area, but is an area where weather plays a more role; for example, the northeastern states? How do storms and freezing cold figure into the plan? Instead of taking a few months to clear, it might takes years. The panel spoke of the diminishing skills of the United States salvage capabilities, but made did not mention possible ways to improve them.

The U.S. Eneergy Information Administration study, “New York/New Jersey Intra Harbor Petroleum Supplies Following Hurricane Sandy: Summary Of Impacts Through November 13, 2012,” studied the results of Hurricane Sandy on New York Harbor and evaluated product flows in the New York Harbor (NYH) area both prior to Hurricane Sandy to November 13. These terminals represent 98 percent of the storage capacity in the New York Harbor area.

The report discusses how petroleum products for the northeast came to a stop because of the storm. The storm did not only stop inbound traffic to the harbor, but also forced the closure of gas and oil pipelines and infrastructure. These pipelines lead to the refineries in northern New Jersey and many of the terminals. The damage to the refineries and the terminals significantly disrupted the supply chain.

With terminals nonoperational, product supply into the region stopped. Colonial Pipeline, which moves substantial volumes of petroleum products from the Gulf Coast to the New York Harbor area, was forced to stop delivering products to the NYH terminals. Colonial also had to slow product movement throughout the entire pipeline, which serves areas from the Gulf Coast, up the East Coast into New Jersey and New York.²²

After the storm, the terminals were only receiving 63 percent of the gasoline that they had been receiving before the storm. This affected recovery operations throughout the region.

“Port of NY-NJ Containers Jumped 16 Percent in 2010,” from the *Journal of Commerce* by Peter T. Leach was chosen because it gave a point of reference for cargo that passes through New York Harbor. It is important because it allowed an understanding of the economic importance of the port. The article explains that there were 4,811 ship calls in the Port of New York and New Jersey in 2010. The port authority stated that the dollar value of all cargo handled in the port during 2010 exceeded \$175 billion.²³ The article continues by breaking the down the cargo into dry bulk, automotive and TEUs. The port’s total general cargo volume, according to data from the U.S. Bureau of Census, increased to 32.2 million metric tons in 2010.

The article was written in March of 2011 and since then new data is available. The most current data is on the New York and New Jersey Port Authority trade stats sheet for 2012. The trade fact sheet shows an increase in cargo export and imports as well as an increase in revenue. In 2010, the dollar value of the all-cargo leaving and entering

²²Energy Information Administration, “New York/New Jersey Intra Harbor Petroleum Supplies Following Hurricane Sandy: Summary of Impacts Through November 13, 2012,” http://www.eia.gov/special/disruptions/hurricane/sandy/petroleum_terminal_survey.cfm (accessed 11 September 2013).

²³Peter T. Leach, “Port of NY-NJ Containers Jumped 16 Percent in 2010,” *Journal of Commerce*, 3 March 2011, https://www.joc.com/maritime-news/port-ny-nj-containers-jumped-16-percent-2010_20110303.html (accessed 15 October 2013).

port was \$175 billion. According to the trade fact stats sheet for 2012, the dollar mount exceeded \$220 billion dollars. The port of New York and New Jersey continues to grow and expand. What the article does not reflect is the effect channel deepening will have on the amount of goods that flow in and out of the port. With the Post Panamax, ships will soon be able to enter the port, how will this affect the amount of trade that takes place.

CHAPTER 3

RESEARCH METHODOLOGY

New York harbor was chosen because of the important role it plays for the United States. It has been ranked in the top three important harbors in the United States based on its location, the amount of cargo that passes through, and the economic impact it has on the local area. The harbor itself is one of the largest natural harbors in the world and the busiest on the eastern seaboard. The entrance to the harbor is at the southern end and is the only way for large ships to enter the ports of New York and New Jersey. The channel leading into the harbor is approximately 800 yards wide and 45 feet deep. There is shoal (water that is too shallow for ship to safely sail in) water on both sides of the channel with a range in depth from 13 to 40 feet. Currently, the channel is undergoing a dredging that will increase the channel's depth to 50 feet. Smaller vessels can still make their way through the harbor if the channel is blocked, but they would not be able to meet the demand of goods.

The economic importance of the harbor is vital to the northeast of the United States. Each year over five million 20-foot equivalent units (TEU) pass through the New York and New Jersey port. The New York and Jersey Port Authority valued the cargo that passes through the port at over 175 billion dollars in 2010, and it increased to 208 billion in 2011, with an estimated 220 billion dollars in 2012. The port's importance is not just measured in dollar amount but also in the importance of the goods that are delivered. Most of the fuel oil that is used in the northeast is delivered into this port. As well as consumer goods, the port also serves as a major hub for shipping goods overseas.

to Europe and the Middle East. By breaking down the type of goods that flow into the harbor, the possible economic impact to shutting down the harbor can be deduced.

There are many types of mishaps that could occur with a ship while underway and in port to include fires, mechanical failures, and willful destruction of the cargo or vessel. In addition, there are many types of ships, each posing their own type of threat to the channel and harbor. This study will investigate if a LNG tank can be used as a floating bomb, or is the threat from a LNG not as great as one would believe. LNG tanks hold millions of gallons of liquid gas, that if converted to a vapor would pose a major threat.

Container vessels can range in size from 500 hundred feet in length to over 1,200 feet in length, and they are important classes of ships because of the type of cargo they carry. These ships could pose a major problem if one sank in the channel. Container ships are not only very large, but the containers they carry can break free and drift in the channel. The sinking of the ship would not only block the channel, but also create a hazard to navigation that could affect smaller vessels in the harbor. This study will explore the preventative and safety measures onboard to prevent spillage of cargo.

An Ultra Large Crude Carrier (ULCC) would compound the problem if one of these types of ships sank in the channel. The sinking of one of these large crude carriers creates not only an economic concern, but an environmental one as well. The author will be looking at the safety measures these carriers have, and what could be done to prevent the crude from leaking and becoming a major environmental disaster. The Exxon Valdez that ran aground on March 24 1989 will be used as a case study on which to base the possible impact.

By comparing data from the United States Coast Guard, Department of Transportation, Department of Homeland Security and Department of Defense databases, and looking at how long it has taken to from vessels that have sunk in key areas, the author will look at how long it took to remove the USS Cole from the Yemen harbor after the terrorist attack. Another recent example is the removal of the USS Guardian off the reef near the Philippines in 2013. Looking at vessels on a larger scale, this study will evaluate the righting and removal of the Costa Concordia, an Italian cruise ship? Off a reef off Isola del Giglio, Tuscany, Italy. The cruise ship will provide a prime example of how to remove a sinking or sunken vessel of a larger scale. This paper will explore the possible ways to mitigate the closing of the harbor and ways to improve the way resources are used. The research will investigate the United States Coast Guard's plans for a response to this type of incident and looking at the Department of Homeland Security plans for a response. Another agency that will be examined is the Environmental Protection Agency (EPA), based on the impact of the contents of the ship, whether it is oil, gas, or chemicals. Those are a few, but not all of the factors. All variants of cargo will have an impact on the spillage.

There are ways to mitigate the impact to the area if the harbor and channel are shut down. Larger ships could be rerouted to other major harbors, but that would require each ship be notified in advance so that it could re-plot its course. Smaller shipping vessels might be able to navigate around the wreck if they have a shallow enough draft. This research will investigate how long these smaller ships would be able to maintain the flow of goods and resources into the city. Next, the study will investigate how long the harbor would be closed and what the timeframe is for removing the ship.

There are many factors that go into determining how long it will take to remove a ship from the channel. The size of the ship, the cargo the ship is carrying, how the ship sank (did it capsize or sink straight down), and the environment of the area (current, weather, seas) are all factors that must be thoroughly investigated. By looking at how to reduce the economic impact of the channel being closed, this thesis will determine which is a more realistic option, removing the ship or dredging a new channel. Data for the foregoing analysis will come from multiple salvage operations from around the world, including the salvage of the Costa Concordia, an Italian cruise ship which sank off the reef of Isola del Giglio, Tuscany, Italy. The findings will be based on previous salvage removal jobs. These include the removal of the wreck of the Motor Vessel Rena, a container ship which sank off New Zealand in 2011, which currently stands at \$240 million, and the removal of the MSC Napoli, on the southern coast of the United Kingdom in 2007, which took two and a half years to complete at a cost of \$135 million. Ship salvage can range from a few months for smaller ships, to a few years with an estimated cost of hundreds of millions of dollars. This estimate is based on the assumption that the equipment needed to conduct the job is available, since some equipment is very specialized and normally used in the oil industry. This equipment is also under contract with other nations which may cause a delay in receiving it when needed. The United States does have heavy salvage equipment, but not everything needed to complete a major salvage operation is readily available. There has not been a sinking or salvage operation in the past 100 years in New York harbor. Ships have caught fire and run aground, but those either took place at the pier, or the ship was able to make it to an emergency anchorage.

The cost and time of two current projects will be compared. The first is the Army Corps of Engineers project of widening New York and New Jersey channel and the Panama Canal. The widening of the New York and New Jersey channel will take a total of 10 years. This channel is over 38 miles in length and is to be completed in 2014. The project will be used as a basis to determine how long it would take to dredge a new channel if needed. The widening of the Panama Canal will cost over five billion dollars and that project is of a much greater scale. However, the equipment required to widen the channel is the same as needed to dredge a new channel in New York harbor. Based on the cost of the project, and the amount money the government would lose if the harbor was closed, the decision would not belong to the city of New York, but to the federal government because of the impact the closure would have on the eastern seaboard.

CHAPTER 4

ANALYSIS

Cargo ships are becoming larger each year, and more and more shipping traffic is passing through our ports. What would happen if one of these large ships sank at the mouth of a harbor? New York Harbor is one of the most important harbors in the United States. The harbor is the third busiest in the country. Each year, hundreds of billions of dollars of cargo and goods pass through. This chapter will discuss the importance of keeping the channel clear, and the possible repercussions if the channel does get blocked for an extended period of time. With the channel over 1,000 feet wide, there are many types and sizes of ships that pass through, to include container ships, Large Natural Gas (LNG), Ultra Large Crude Carriers (ULCC) Bulk carriers, and passenger ships.

The purpose of this research is to understand the impact of a large container vessel sinking in the channel of New York City harbor, causing chaos to harbor traffic scheme, the economy, and the security to the local region. This incident could shut the harbor down, causing the rerouting of shipping, billions of dollars in delays, the loss of services, and affecting port security. This event would have a major impact not just on New York harbor, but to all the major harbors along the eastern seaboard and the Gulf of Mexico. Can these other ports absorb the extra shipping traffic? The smaller ports do have anchorages where large ships can port and try to off load the cargo. This chapter will look at what salvage capabilities the United States has, and if they are sufficient to handle an operation of this scale. Additionally, the agencies that will be involved in clearing the channel and discussing the likelihood of a terrorist attack or a mechanical failure will be addressed.

This chapter will be structured in the following order:

1. Why New York Harbor, and what makes the channel leading into the harbor different from other major harbors in the United States? This will include the physical layout of the channel and background information about the channel.
2. The types of ships that would have to be used to block the channel, and the alternatives to getting cargo to its destinations. Can an LNG or ULCC tankers be used as a large floating bomb?
3. Is the blocking of the channel a terrorist attack or a mechanical failure? What is currently being done to prevent an attack and what security measures can be improved?
4. What is the effect on the local and national economy if the channel is blocked and how would this affect international commerce? With the channel blocked, many ships would need to be re-routed to other ports or would need to have cargo off loaded via alternate means.
5. The salvage capacity of the United States will be explored. If the salvage equipment the United States owns is available, will it be able to complete the salvage in a timely manner? What are key factors that will affect the removal of the sunken ship? If the United States does not have all the required equipment, who does?

The port of New York is one of the oldest ports in the United States and has been in use since the nineteenth century. The port has played a major role in the country's history from the Colonial era to World War Two. In the late nineteenth century, the port was the first thing immigrants saw, and is home to the Statue of Liberty. New York

harbor is the third largest port in the United States and the largest natural port in the country. The port is broken up into six terminal areas: APM Terminals, Maher Terminal, Port Newark Container Terminal, Global Marine Terminal, New York Container Terminal, and Red Hook Container Terminal. It is however, the largest port on the east coast of the United States, accounting for over 50 percent of imported goods. The harbor is distinctive in the fact that there is only one entrance for large ships to enter the harbor. The New York harbor covers nearly 50 square miles with over 650 miles of shoreline. The channel itself is over 240 miles in length. The depth of the channel ranges from 17 feet at its shallows, to a new dredged depth of 50 feet. The United States Army Corps of Engineers (USACE) is currently dredging the channel, which is to be completed in 2014. Currently the maximum depth of the channel is 45 feet, and is unable to accommodate the new post panama²⁴ ships. The channel is currently undergoing a dredging to increase the depth to 50 feet, which will allow post Panamax ships to enter the harbor.

The following data is based off 2012:²⁵ NY/NJ PA

1. 210 billion dollars in cargo.
2. Over one million automobiles.
3. Employs over 269,000 full time workers.
4. Generates over 12 billion in annual wages and two billion in local tax revenue annually.
5. Serves 35 percent of the United States population.

Over five million Twenty-Foot Equivalent unit (TEUs) pass through the port.

²⁴Marine Connector.

²⁵The Port Authority of New York and New Jersey.

There are many types of ships that sail the world's waterways. The ships vary in task, purpose, and size. These ships can carry just about anything ranging from passenger ships, to bulk carriers and petroleum products. Ship size and weight has increased as the demand for goods has increased (see figure 1). These range in length from 400 feet to over 1,500 feet, with the largest ULCC grossing over 800,000 tons fully loaded. These ships are larger than an aircraft carrier.

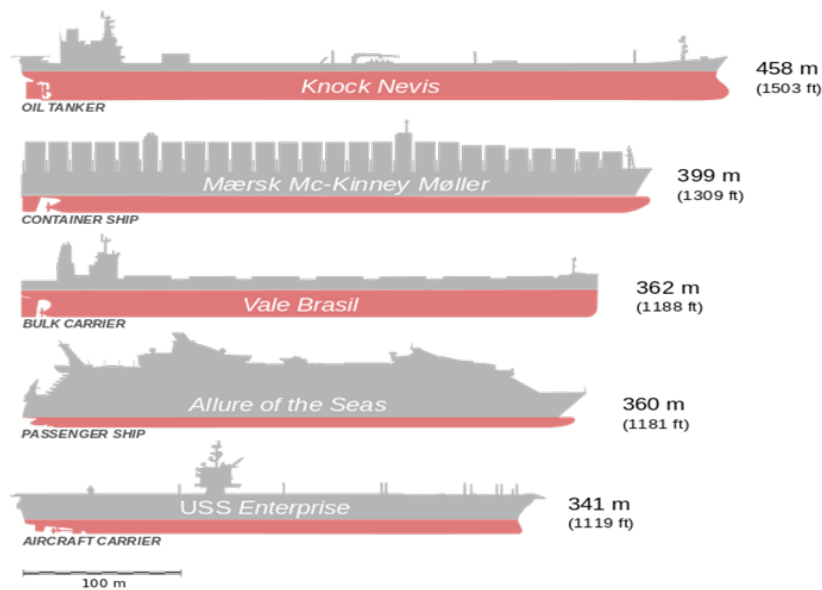


Figure 1. Ship Size Comparison

Source: Wikipedia Encyclopedia, "List of World's Longest Ships," http://en.wikipedia.org/wiki/List_of_world's_longest_ships (accessed 16 August 2013).

In this age of terrorism, almost anything can be used as a weapon or pose a threat to the United States. With 80 percent of the world's commerce transporting over the oceans, there is a threat of an extremist organization hijacking or pirating a ship and using it as a weapon. In the report by LCDR Cindy Hurst "The Terrorist Threat to Liquefied

Natural Gas: Fact or Fiction?” this very topic is discussed. Since September 11, 2001, al-Qaeda has been trying to expand its ability to attack the west. The natural progression was to look to the sea as another way to attack and cripple the west. What is LNG? LNG is liquid natural gas.

The threat of attack on United States shipping was based on a call from the Saudi Arabian arm of al-Qaeda on 14 February 2007. Al-Qaeda wanted to cripple the United States economy and understood the United States dependence on foreign oil and gas. These terrorists looked at attacking tankers out at sea and in port with the goal of denying the United States oil and gas. Another option was using a LNG tanker as a giant bomb. The premise was that the terrorists would capture one of these tankers, sail it into a United States port, and then detonate it. Liquid Natural Gas has a boiling point of -259 degrees²⁶ Fahrenheit, meaning that any temperature above that will change the liquid to a gas state. It is possible that the rapid release of gas could create a Boiling Liquid Expanding Vapor Explosion (BLEVE) if the conditions are right. The window to create a BLEVE is extremely small and highly unlikely. Al-Qaeda even had manuals describing how to turn these ships into giant bombs.²⁷

How much LNG can one of these ships carry? The largest of the LNG tankers is classified as a Q-max class. This is the largest size tanker that can dock in Qatar LNG terminals. The “Q-Max ship is 1,132 feet long, 177 feet wide and 114 feet high, with a draught of approximately 39 feet. It has a capacity of 266,000 cubic meters (9,400,000 cu

²⁶California Energy Commission, “Liquefied Natural Gas (LNG) as a Transportation Fuel,” www.consumerenergycenter.org/transportation/afvs/LNG (accessed 12 May 2013).

²⁷Blanche.

feet), equal to 161,994,000 cubic meters (5.7208×10^9 cu feet) of natural gas.”²⁸ Using the capacity of the Q-Max tanker, the blast radius is greater than 2,000 yards.²⁹

Since New York harbor does not have an LNG terminal, this study will use the scenario of a LNG carrier attacked by a group of extremists that turns it into a bomb. This scenario is extremely unlikely because of the security protocols used by the ships and the ability of the attackers to turn the liquid gas into a vapor for ignition. Based on findings and known evidence from the Department of Energy and Department of Homeland Security, LNG carriers are not considered an explosive threat because of the following reasons:

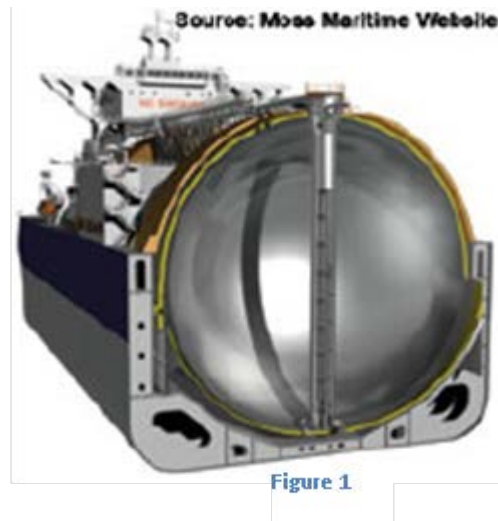


Figure 2. LNG Tanker Design

Source: Moss Maritime, “LNG Tanker Design,” <http://www.mossw.com/technologies.php> (accessed 23 June 2013).

²⁸Maritime Connector.

²⁹Government Accountability Office, *Maritime Security*.

1. LNG tankers are designed with mechanical safety relief valves³⁰ (see figure 2).
2. The liquid tanks are independent of each other and devoid of oxygen.
3. Security onboard LNG tanker, and the increased training the crews are receiving from Society of International Gas Tanker and Terminal Operators LTD.
4. The extremely low boiling point of LNG; once the liquid turns to gas there is a brief opportunity for the gas to mix with oxygen before it dissipates.

Liquid Natural Gas has one of the best safety records in the industry. “More than 135,000 LNG carrier voyages have taken place without major accidents, safety or security problems, either in port or at sea”³¹ according to The International Group of Liquefied Natural Gas Importers. If terrorists choose to spill the gas into a harbor to create an environmental disaster, the spill would not be as effective as the terrorists hoped. This is in part to the fact that the LNG has a low boiling point. Once the gas is released, it begins to transition into a vapor. Maritime security has become more of a concern in the past 10 years due to the increase of hijackings along the Horn of Africa and the Gulf of Aden. The shipping industry has increased ship crew and reporting training to allow an immediate response if they come under attack. One of these new systems is the Global Maritime Distress and Safety System (GMDSS). It is an integrated communications system using satellite and terrestrial radio communications to ensure that no matter where

³⁰Moss Maritime, “LNG Tanker Design,” <http://www.mossww.com/technologies.php> (accessed 23 June 2013).

³¹The International Group of Liquefied Natural Gas Importers, “The LNG Industry,” 2011, <http://www.giignl.org/> (accessed 3 March 2013).

a ship is in distress, aid can be dispatched.³² The claim that a terrorist could use a Rocket Propelled Grenade (RPG) to penetrate the hull of a LNG tanker is simply false.

The likelihood of a terrorist or extremist organization hijacking an LNG tanker is highly unlikely. With the improvements to security on board these ships, the chances for extremist or hijackers to take over the ship is very slim. Even if they could take over the ship, the chances that the hijackers could get the natural gas vapor to mix with the right percentage of oxygen is slim. There will always be a chance that it could happen since nothing is impossible. For the purpose of the scenario, the possibility that it is a terrorist plot is ruled out for the following reasons:

1. There is no historical data that this has happened in United States waters.
2. The likelihood that a ship will sink or wreck due to mechanical failures has a much higher probability. This is because of a growing number of ships that transit our waters.

On the other hand, Ultra Large Crude Carriers do present a major maritime security issue. Like the LNG tanker, ULCC's have undergone major security changes including better training for the crew and GMDSS. There are however, two significant differences; there are oil terminals near New York Harbor, and ULCC do not have the same safety record that LNG tankers have. Oil tankers have had their share of fires with one of the most recent being October 11, 2013 in China.³³ ULCC also presents an extremely tempting target for use as an environmental weapon. The Exxon Valdez was a

³²International Mobile Satellite Organization, "Global Maritime and Safety Distress Systems," <http://www.imsa.org/GMDSS.asp> (accessed 21 October 2013).

³³Bloomberg, "7 Dead after Oil Tanker Explodes," GCaptain, 12 October 2013, <http://gcaptain.com/dead-tanker-explodes/> (accessed 21 September 2013).

much smaller ship and still released 260,000 barrels of crude oil. The oil eventually covered 1,300 miles of coastline, and 11,000 square miles of ocean.³⁴ If something like this happened inside of the New York Harbor, the results would catastrophic.

The USCG currently uses this scenario. under the Coast Guard's nightmare scenario, it would happen with a light snow falling in the dead of winter, on a late Friday afternoon of a holiday weekend, with a flood, or incoming tide guaranteed to spread the oil far and wide throughout the harbor and up the Hudson River (at least the lower part subject to tidal action). Within 24 hours, with two flood tides having churned through the Verrazano Narrows, the oil would lap the shores of Liberty Island where the Statue of Liberty stands as one of New York's most popular tourist attractions.³⁵

Sinking a vessel in the channel will not only have an economic impact, but an environmental impact as well. The flow of the tide and the weather at the time will determine the impact of the spill. In the short-term, the effects may be compensated with on-hand supplies; but the more time passes, the greater the impact. The possibility of an oil spill similar to the Exxon Valdez is very slim, but it could happen. If a tanker collides with another ship and does not sink in the channel, but is able to move to an anchorage, the crude oil would still leak out into the harbor and cause a shutdown. The tidal current in New York harbor moves at five knots and would spread the oil swiftly throughout the harbor unless the spill was contained. Using the Exxon Valdez as an example, nearly 11 million gallons of oil was released into Prince William Sound.³⁶ The oil covered over

³⁴Exxon Valdez Oil Spill Trustee Council, "History," Wayback Machine, <http://web.archive.org/web/20070630224835/www.evostc.state.ak.us/History/FAQ.cfm> (accessed 12 August 2013).

³⁵Brian Thompson, "Oil Spill Fears in New York Harbor: They're Real," NBC News, 20 September 2010, <http://www.nbcnewyork.com/news/local/Oil-Spill-Fears-in-New-York-Harbor-Theyre-Real-103298494.html> (accessed 6 August 2013).

³⁶Environmental Protection Agency, "Exxon Valdez," <http://www.epa.gov/oem/content/learning/exxon.htm> (accessed 7 May 2013).

1,300 miles of shoreline. The recovery effort lasted four summers and cost over 2.1 billion dollars.³⁷ The chance of an oil tanker striking rocks and spilling millions of gallons of oil is extremely unlikely because the channel in New Harbor is clearly marked. Since the Exxon Valdez disaster, Congress has passed the Oil Pollution Act of 1990, which required the Coast Guard to improve its regulations on oil tank vessels and oil tank owners and operators. Newer oil tank hulls offer better protection against spills, and communications between ship captains and ship traffic centers have improved.

The chance of two ships colliding is a more likely possibility. As a naval officer I have seen warships collide that are manned by extremely well trained crews. Commercial shipping is a highly competitive business that does not train their crews as well as a military ship, resulting in ship collisions happening more often than ship's running aground. Another likely reason is the volume of ships that passes through the channel each year. There are over 4,000 ships that pass through the channel each year, placing many very large ships in a very narrow channel. If a ship plots the wrong course by one or two degrees it can lead to a collision.

Using a container vessel, on the other hand, presents a likely set of challenges because of their size, the type of cargo (mainly TEU's) and the number of these types of ships that pass through the harbor every year. According to the Journal of Commerce, 4,811 ships entered the harbor in 2010.³⁸ These ships vary in size from a small feeder that can carry up to 1,000 TEUs to the Ultra Large Container Vessel (ULCV), which can hold 15,000 TEUs. The likelihood of a container vessel sinking is greater than a LNG based

³⁷Exxon Valdez Oil Spill Trustee Council.

³⁸Leach, 1.

on ship design. Cargo ships only have two percent of the cargo physically inspected and the TEUs can be stacked eight high or greater. A flag vessel of a foreign country that is a party to the Safety Convention must be certified and inspected by that country. A flag vessel of a foreign country that is not a party to the Safety Convention will be inspected prior to entering a United States port.³⁹ Other nations do not have the same inspection requirements as the USCG. This leads to ships that are not up to the same standards and can lead to questionable seaworthiness of a vessel. The sinking of one these vessels would block the channel and the cargo would present a navigational hazard to all shipping in the harbor because of the TEUs. Some of these units would break free and float away, either on the surface or just beneath it. With nearly 10,000⁴⁰ TEUs lost at sea in 2012 it is likely that if one of these ships sinks, the cargo would break free. The cause is either a structural and or mechanical failure, or a case of poor seamanship. Poor seamanship comes from the poorly trained crews of these ships. Many of these crews are piecemealed together at the last minute with little training and even at times do not speak the same language. This is a result of Flag of Convenience (FOC), which means that nations will register their ship with another nation that has less restrictive laws and standards to avoid taxes. It is not just container ships that use FOC, but all classes and types of merchant ships, to include ULCCs and LNG tankers. The ULCCs and LNG need

³⁹U.S. Coast Guard, “Merchant Vessel Inspection and Documentation,” <http://www.uscg.mil/international/affairs/Publications/MMSCCode/english/Chap13.htm> (accessed 7 May 2013).

⁴⁰Janice Podsada, “Lost Sea Cargo: Beach Bounty or Junk?,” *National Geographic*, 19 June 2001, http://news.nationalgeographic.com/news/2001/06/0619_seacargo.html (accessed 8 July 2013).

to adhere to the International Maritime Organization.⁴¹ Merchant ships that fly the United States flag are required to follow very strict guidelines laid out by the Department of Transportation (DOT) and the United States Coast Guard (USCG).

Structural and or mechanical failures are the result of cutting corners to increase profits and leads to poorly trained crews. A structural and or mechanical failure would be the mostly likely cause of a ship sinking or wrecking in the channel. A New Panamax or Post Panamax for example would block the channel due to the sheer size of the ship and the amount of TEUs that it carries. The channel is being dredged to 50 feet so that when the tide is at its lowest point there is 50 feet of navigable water.⁴² This class of ship has a draft of 40 feet or greater. On both sides of the channel, there is shoal water. That is water that is not safe for ships to sail through because the water is too shallow or there is an obstruction. If a ship sank or collided with another ship in Ambrose channel (channel that leads into New York harbor) between Sandy hook and Rockaway Point at the line of demarcation (the area where the bay meets the ocean), the results would close the channel. Using the charts and tidal current information for the area will help figure out where the cargo would go; would it flow into the harbor or out into Open Ocean? If the tide were heading out, then the cargo would drift out to sea but if it were an inbound tide, then the cargo would float into the harbor. Whether it is a crude carrier or a container

⁴¹International Maritime Organization, "International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW)," [http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-on-Standards-of-Training,-Certification-and-Watchkeeping-for-Seafarers-\(STCW\).aspx](http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-on-Standards-of-Training,-Certification-and-Watchkeeping-for-Seafarers-(STCW).aspx) (accessed 17 August 2013).

⁴²National Oceanic and Atmosphere Association, "NOAA Chart 12327," <http://www.charts.noaa.gov/OnLineViewer/12327.shtml> (accessed 11 October 2013).

ship, some of the cargo will be lost forcing the shutdown of the channel. If a container ship collided or sank, the force of the impact would dislodge the cargo forcing it to fall off the ship. Every year nearly 10,000 TEUs are lost at sea based on a study from the Monterey Bay Aquarium Research Institute (MBARI).⁴³ The amount of TEUs depends on the size of the ship, the amount that were onboard and the force of the impact. The TEUs that were knocked overboard is an issue for the following reason:

1. Some of these TEUs will float just below the surface of the water making them hard to see and can affect other vessels that are transiting the waterway.
2. Others will sink in place, which is an issue because of the channel depth. A TEU is eight feet six inches tall, this obstruction in the channel will reduce the amount of navigable water other ships could use.

With the channel shut down and larger ships unable to enter the harbor, this starts to have an economic impact not just on New York City, but the east coast and possibly the gulf coast states as well. In 2012 over 210 billion dollars in cargo was imported and exported (see figure 3).⁴⁴ By taking this number and dividing it over 365 days, this results in an average daily income of 575 million dollars. For each day the Harbor is closed the City of New York loses nearly five and a half million dollars in tax revenue.

⁴³Monterey Bay Aquarium Research Institute, "MBARI teams with Monterey Bay National Marine Sanctuary to study effects of shipping containers lost at sea, 7 March 2011, http://www.mbari.org/news/news_releases/2011/containers/containers-release.html (accessed 11 September 2013).

⁴⁴The Port Authority of New York & New Jersey, "2012 Trade Stats Sheet," <http://www.panynj.gov/port/trade-stats.html> (accessed 22 July 2013).

Tonnage	General Cargo (Thousands of Metric Tons)			
		2011	2012	% Change 11/12
	Imports	21,910.5	22,549.1	3%
	Exports	<u>11,985.7</u>	<u>11,764.6</u>	-2%
	Total	33,896.2	34,313.7	1%
	Bulk Cargo			
Dollar Value	Imports	39,986.8	35,058.9	-12%
	Exports	<u>12,469.2</u>	<u>11,429.2</u>	-8%
	Total	52,456.0	46,488.1	-11%
	Total Cargo Tonnage	86,352.2	80,801.8	-6%
	Source: U.S. Dept of Commerce, Bureau of Census-GTI			
	General Cargo (Millions of U.S. Dollars)			
Container Trade		2011	2012	% Change 11/12
	Imports	\$117,477	\$122,940	4.7%
	Exports	<u>\$48,897</u>	<u>\$48,265</u>	-1.3%
	Total General Cargo	\$166,374	\$171,205	2.9%
	Bulk Cargo			
	Imports	\$32,697	\$30,614	-6.4%
TEUs	Exports	<u>\$8,797</u>	<u>\$8,750</u>	-0.5%
	Total Bulk Cargo	\$41,495	\$39,364	-5.1%
	Total Dollar Value	\$207,868	\$210,568	1.3%
	Source: U.S. Dept of Commerce, Bureau of Census-GTI			
	TEUs			
Imports		2011	2012	% Change 11/12
	Imports	2,766,102	2,817,805	1.9%
	Exports	2,683,689	2,749,570	2.5%
	Imports	82,413	68,235	-17.2%
	Exports	2,737,584	2,712,104	-0.9%
	Imports	1,621,265	1,543,298	-4.8%
Total TEUs (loads and empties)	Exports	<u>1,116,119</u>	<u>1,168,806</u>	4.7%
	Total TEUs (loads and empties)	5,503,486	5,529,909	0.5%
	Total Containers (loads and empties)	3,197,016	3,210,809	0.4%
	Source: PONY Terminal Operator Data			

Figure 3. Trade Sheet Data

Source: The Port Authority of New York & New Jersey, “2012 Trade Stats Sheet,” <http://www.panynj.gov/port/trade-stats.html> (accessed 22 July 2013).

The economic impact to the area would be widely felt. The longer the channel remained blocked the worse the impact would become. During Hurricane Sandy in 2012, the harbor was closed for a week. This created a shortage of fuel and food in the local area. Food and fuel were brought in from outside the state via trucking convoys and train. The fuel that was trucked in was directed for use in emergency vehicles and then rationed out to the people. In a best-case scenario in which the ships just collided and did not sink and the cargo could be recovered or pulled out of the channel, the local economy would be able to absorb the disruption in services and goods. If the ship did sink in the channel and the channel became blocked, the outcome would be completely different. The harbor authority would have to notify all shipping companies of the channel closure. This would force the shipping companies to re-route their ships to other ports for off load. That in its

self is an issue because not all ports have the same capabilities. Some of the ports are not deep enough to accommodate the larger ships like ULCC or Post Panamax.

Another issue is that these secondary ports already have ships scheduled to dock and would not be able to absorb the over flow from New York (see figure 4).⁴⁵ What ports would these be rerouted to? The next two largest on the east coast are the Port of Savannah and the Port of Virginia. The Port of Savannah is the second largest on the east coast. This port has the capability to offload the cargo and might be able to absorb a few of these ships, as would the Port of Virginia. With New York harbor restricted due to the channel being blocked, how would goods make it to the port? Small ships with a much shallower draft will continue to transit in and out of the harbor and continue on their port of call. The larger container ships do have an organic means of offloading. Container ships have cranes that can offload to barges and crude carriers have transfer pumps that can offload the oil to smaller ships as well. These capabilities are useful and are a good short-term solution, but the problem that arises is whether there are enough barges and small ships to compensate. Looking at a comparison chart, one can determine how many barges it would take to equal one small ship (see figure 5).⁴⁶ As seen in the chart below, you would need 100 barges to equal a ship that is carrying 6,000 TEUs, the Post Panamax ships can carry two to three times the amount of TEUs. According to The American

⁴⁵USA Trade Online, “Annual Port-level Imports and Exports,” U.S. Census Bureau, <http://www.usatradeonline.gov/> (accessed 28 August 2013); Department of Transportation, Bureau of Transportation Bureau Fact Sheets, “Atlantic Port Call by Tonnage 2009,” http://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/bts_fact_sheets/october_2010/html/figure_04.html (accessed 28 August 2013).

⁴⁶The American Waterways Operators, “Ship Capacity vs. Other Means,” <http://www.americanwaterways.com/initiatives/jobs-economy/industry-facts> (accessed 19 August 2013).

Waterways Operators, there are approximately 27,000 thousands barges in the industry. This may seem like a lot, but that number covers the entire nation. Approximately 13 ships arrive and depart form the harbor⁴⁷ each day. That means at least 2,000 extra barges would be needed assuming that not every ship needed to offload to a barge.

⁴⁷Number derived from dividing 4811 ships by 365 days



Figure 4. Atlantic Seaport Tonnage Capacity

Source: Bureau of Transportation Statistics, “Atlantic Port Call by Tonnage 2009,” U.S. Department of Transportation, http://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/bts_fact_sheets/october_2010/html/figure_04.html (accessed 28 August 2013).

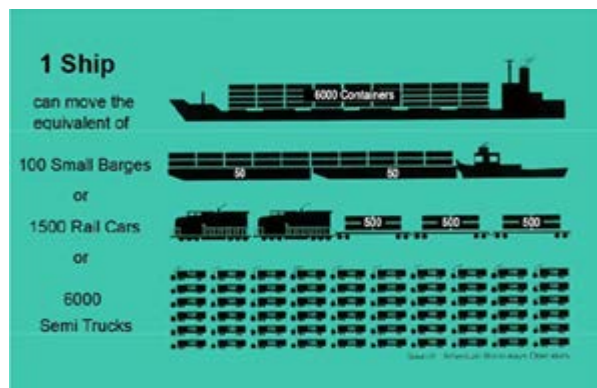


Figure 5. Ship Capacity vs. Other Means

Source: The American Waterways Operators, “Ship Capacity vs. Other Means,” <http://www.americanwaterways.com/initiatives/jobs-economy/industry-facts> (accessed 19 August 2013).

The government would need to intervene in this emergency because this problem will affect not only the local area, but also nearly half the nation spanning from New York to Texas. Another aspect of the problem is prioritizing which ships and cargo would get offloaded first. According to the Maritime Infrastructure Recovery Plan (MIRP) for the national strategy for maritime security April 2006⁴⁸ DHS would be the Principal Federal Official (PFO) in this emergency and is supported by the USCG, U.S. Customs and Border Protection (CBP), Emergency Preparedness and Response/Federal Emergency Management Agency (EP&R/FEMA), Office of Intelligence and Analysis (I&A), U.S. Army Corps of Engineers (USACE), DOT, DOS and Maritime Administration (MARAD) to name a few. Each one of these agencies has a key role in this. USCG would perform the following;

As the Captain of the Port (COTP)/ Federal Maritime Security Coordinator (FMSC):⁴⁹

1. Develop and implement Area Maritime Security(AMS) Plans;
2. Control vessel traffic, movement and anchorage;
3. Establish and enforce safety and security zones;
4. Control access to and operations of facilities under, in, or adjacent to waters subject to the jurisdiction of the U.S.
5. Control the movement of vessels carrying Certain Dangerous Cargos (CDC).

⁴⁸Homeland Security Digital Library, *The Maritime Infrastructure Recovery Plan For The National Strategy For Maritime Security*, April 2006, <http://www.hsd1.org/?view&did=462514> (accessed 2 June 2013).

⁴⁹*Ibid.*, 13.

U.S. Customs and Border Protection is another agency which is a key player. They would work with Department of State to ensure rerouted cargo can pull into Canada and/or Mexico for offloading and transportation back to the United States. The United States Navy is the lead agency in salvage operation under 10 U.S.C. §7361-7364 (Salvage Facilities Act)⁵⁰ which authorizes the Secretary of the Navy to provide necessary salvage facilities. The Supervisor of Salvage and Diving (SUPSALV) reports to the Commander, Naval Sea Systems Command or NAVSEA. The Office of the Navy Supervisor of Salvage (SUPSALV) is uniquely positioned and enabled by the Salvage Facilities Act⁵¹ to coordinate input from the commercial salvage industry in response planning and to focus the operational contribution of commercial salvage during an actual incident. This would allow SUPSALV to acquire any salvage equipment that is needed. SUPSALV would provide salvage expertise to the U.S. Army Corps of Engineers for maritime salvage operations. The U.S. Army Corps of Engineers has a very important role since their job would be to dredge a new channel around the sunken vessel. The decision to dredge or salvage would be discussed by the Mayor, Governor, and DHS since that agency is the PFO. The main questions are: (1) How long would it take to salvage a vessel of this size? (2) How long would it take to dredge channel around it? (3) How much would it cost? By using the Motor Vessel Rena as a comparison, one can estimate the time and cost for recovery. Motor Vessel Rena is a Panamax size ship that is capable of carrying over 3,000 TEUs that ran aground near Tauranga, New Zealand, in

⁵⁰Cornell University Law School, 10 USC , §7361-7364, Chapter 637, *Salvage Facilities Act*, <http://www.law.cornell.edu/uscode/text/10/subtitle-C/part-IV/chapter-637> (accessed 17 August 2013).

⁵¹*Ibid.*

October of 2011. As of August 2012 Salvage operations were still ongoing at a cost of over 200 million dollars.⁵² Using the Post Panamax ship nearly doubles the size and capacity, and you can expect a much higher cost. The length of time it would take would also increase, not simply because it is a bigger job, but because New York harbor is a more precarious location. The current of the harbor is an important factor since it is in excess of five knots which would create a danger to the divers and slow the progress of the operation as well. The second factor is the weather of the northeast. With a full range of seasons, the water temperature changes from above freezing to 70 degrees.⁵³ To compound the issue further, hurricane season starts in late summer or early fall for the northeast. This past season has been mild with just a few tropical storms. The last hurricane the city had was Hurricane Sandy⁵⁴ which devastated the area. During Hurricane Sandy the region suffered one of the worst fuel shortages because of a disruption in the supply chain. In a report to New York City Mayor Michael Bloomberg, the following was stated:

Sandy triggered one of the most severe fuel shortages in the City's history by damaging energy infrastructure along the regional supply chain, including terminals, pipelines, refineries, and the electricity infrastructure that serves these assets. Although some gas stations were damaged by storm surge, the majority of the City's retail gas stations were not, and with the exception of the Rockaways,

⁵²The Maritime Executive, "Resolve To Remove MV Rena Wreck from Astrolabe Reef," 3 August 2012, <http://www.maritime-executive.com/article/resolve-to-remove-mv-rena-wreck-from-astrolabe-reef/> (accessed 21 June 2013).

⁵³Department of Commerce, National Oceanic Data Center, "Water Temperature Table of the Central Atlantic Coast," <http://www.nodc.noaa.gov/dsdt/cwtg/catl.html> (accessed 10 August 2013).

⁵⁴New York City Office of Emergency Management, "New York City Hazards: New York City Hurricane History," http://www.nyc.gov/html/oem/html/hazards/storms_hurricanehistory.shtml (accessed 21 September 2013).

did not experience extended power outages; retail gas shortages were a result of not receiving fuel shipments due to disruptions to the regional supply chain.⁵⁵

The storm lasted for only few days; the damage assessment was over 65 billion dollars.⁵⁶

The recovery effort is still ongoing in the tri-state area. This act of nature shut the port down for a few days, but the blocking of the channel and the hazards to navigation would close or restrict access to harbor costing hundreds of millions of dollars in delay of commerce. The port is vital to the prosperity of the area because of the amount of taxes revenue, employment, and trade. Using the wreck of MV Rena as an example, salvage operations began in October 2011 and are still ongoing with the cost for salvage operations currently at 240 million dollars.

The next question is: Does the United States currently have the salvage equipment to conduct this operation? The answer is yes, but that equipment is not sitting idle and ready to respond to this type of contingency. The equipment to remove a sunken ship is under contract with civilian contractors. Most of the heavy lift equipment needed is used by the oil industry. According to *Marine Salvage Capabilities Responding to Terrorist Attacks in U.S. Ports-Actions to Improve Readiness for Transportation Research Board* the United States does have the equipment, but it is not guaranteed that the equipment can be accessed.⁵⁷ Though in the likelihood of a disaster like the blocking of a major channel

⁵⁵Linda I. Gibbs, Co-Chair and Deputy Mayor Caswell F. Holloway, Co-Chair. *Hurricane Sandy After Action, Report and Recommendations* to Mayor Michael R. Bloomberg, May 2013, http://www.nyc.gov/html/recovery/downloads/pdf/sandy_aar_5.2.13.pdf (accessed 21 June 2013).

⁵⁶National Climatic Data Center, “Billion-Dollar Weather/Climate Disasters,” <http://www.ncdc.noaa.gov/billions/> (accessed 13 June 2013).1

⁵⁷U.S. Congress, Report of the Committee for Marine Salvage Response Capability, 22.

or terrorist attack, the heavy lift equipment could be released from their contracts. The equipment needed would include Crane barges, which are floating cranes that are able to lift thousands of tons, Chain cuts that make extensive cuts in a ship hull by the sawing action of a chain using hydraulic rams to move the chain. A puller is a piece of equipment that can drag large sections of hull away. These are just few of the items the salvage teams would need to conduct the operations. Nevertheless, because these pieces of equipment are owned by various corporations and are spread throughout the world getting them on scene would take time. If the heavy lift crane that is needed was currently working in an oil field in the North Sea, it would take a month to stop operations in the North Sea and tow the crane 3,500 miles to New York. The beginning phases of the salvage operation could get underway, but the main effort would not start until the equipment arrived. Using the historical weather data for the area and using recent salvage operations to base this calculation, it can take one to two years or more to remove a Post Panamax ship from the channel based on current salvage operations for MV Rena, which started in October 2011 and is still ongoing. While this is taking place a dredging operation would need to begin as well. Dredging would be the quickest way to reopen the channel based on the current speed at which the USACE is dredging New York channel. The 35-mile deepening project started in 2002 and is expected to be completed in 2014. By dividing the length of the channel by the number of years of the project, the USACE is dredging less than three miles of channel per year. The length of the new channel would need to be two miles to allow shipping to navigate around the sunken vessel. Currently the U.S. Army Corps of Engineers is conducting a channel deepening project for the Port Authority of New York and New Jersey. The project Deepens 35 miles of

navigation channels to 50-53 feet (mean low water) to provide deep draft access to the major container terminals within the Port Jersey of New York and New Jersey. The project includes four separate authorized projects that were consolidated in 2002. The key feature is the deepening of the channel at a total project cost of \$2.5 billion or 208 million dollars per year.⁵⁸ The project is expected to be completed in 2014. This improvement will allow the new larger ships to use the port. This will reduce the amount of ships that need to enter port and increase the amount of goods that can be imported and exported. Dredging a new channel around a post Panamax ship would not take 10 years like the project that is currently underway. This new task would not have the same restraints that the current deepening project has either. This is because the port of New York and New Jersey is a critical port for the United States. The federal government would need to wave many of the current regulations the Environmental Protection Agency (EPA) has in place to allow for a dredging a new channel. The equipment needed to dredge a new channel is available because it belongs to the U.S. Army Corps of Engineers, and the task can be contracted out to private industry. The length of time it would take to dredge a new channel would depend on many different factors:

1. The depth of the water that is being dredged. The deeper the water the less dredging.
2. The environmental condition of the area; is it storm season? Is the water near freezing?

⁵⁸Port Authority of New York and New Jersey, “Harbor-Deepening,” <http://www.panynj.gov/port/harbor-deepening.html> (accessed 10 August 2013).

3. Would current EPA regulations be waved and immunity granted to the dredging company so that the job can be completed quickly.

The EPA would wave restrictions on dredging because of current permissions the USACE is using on the channel-deepening project, and the material that is removed is the same as that of the channel. The excess material can be used to restore tidal wet lands in the area.

In summary New York harbor is a critical port to the United States. As the largest port on the east coast of the country it accounts for over 50 percent of goods imported and exported over the Atlantic Ocean. The author does not feel a nLNG tanker would be used as a floating bomb. There have been too many new security advancements in onboard LNG ship design to include fail-safes on the LNG tanks, the Global Maritime Distress and Safety System (GMDSS), and the limited capability of the extremist trying to take over a vessel. These security upgrades apply to crude carries and container ships as well, and make using them as a weapon very unlikely. A container ship sinking in New York Harbor is a more likely scenario due the high traffic of the harbor.

A ship carrying thousands of TEUs sinking in the channel has proven to be a challenge to the local and federal government because of the importance of the port and the ability to remove the ship and its cargo. This type of wreck can be removed, but with a very high cost and time as seen with MV Rena. Dredging a new channel around a wreck so that harbor traffic can flow with minimal restrictions and help ease the economic impact to the nation. The U.S. Army Corps of Engineers could be used to dredge a new channel with SALSUP and private corporations could work to remove the wreck from the harbor. However, there has never been an accident like this that has taken

place in the harbor. Shipwrecks that have taken place occurred outside of the channel; the ships were at the pier or able to be towed out of the channel. The issues that arise question the United States ability to get the salvage equipment it needs in time to remove a ship that is blocking a port. Should the nation its own equipment just in case a situation like this occurs? Alternatively, is a nation better off with the status quo? Since a problem like this has not happened before, is it worth the cost to buy and maintain the heavy equipment as needed?

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The United States has many ports and waterways. Some of these ports and waterways have greater importance than others. These ports are considered a strategic port for the nation. New York harbor is one of these ports. The harbor and port is the largest on the east coast and accounts for over 50 percent of the exports and imports on the Atlantic coast. New York harbor is split into six ports. Each port is capable of berthing ships of the Panamax and Post Panamax size. The previous chapter explored what would happen to the nation if New York harbor was blocked and forced to close.

The purpose of this research is to understand the impact of a large merchant vessel sinking in the channel of New York City and blocking the harbor. Under this scenario, such an event would cause chaos in the harbor, affect the economy, and affect the security to the local region. The scenario of a large merchant ship sinking and blocking the channel is more likely than a terrorist organization capturing a vessel and using it as a weapon against the United States. The uses of an LNG tanker as a floating bomb is highly unlikely because of the upgrade safety features on ships to include the Global Maritime Distress and Safety System (GMDSS). A ULCC and LNG tanker leaking into the harbor would create a massive environmental issue for the harbor. An event like this would have a major impact not just on New York harbor but also to all the major harbors along the eastern seaboard and the Gulf of Mexico. The removal of a shipwreck that is blocking the channel would cost hundreds of millions of dollars and take years to complete. Dredging a new channel would be needed. Financially, it would be less expensive and open the channel sooner. Other aspects addressed are the agencies

that will be involved in clearing the channel and the likelihood of the sinking being a terrorist attack or a mechanical failure.

This chapter will give a brief summary of the findings from chapter 4. It will explain the results and what they mean. Some of the findings were unexpected and led to other questions. This will be followed by recommendations and topics for further study. This study found that the threat from LNG tankers is not as great as one would have thought. These tankers have evolved over the years to become one of the safest ways to transport liquid natural gas. As noted in chapter 4 these ships have one of the highest safety records in the shipping industry. LNG tankers have numerous safety features that prevent them from becoming the “giant floating bombs.” ULCC and other classes of crude carriers have adopted similar safety upgrades to prevent them from becoming weapons in the hands of extremists. Container ships pose different problem because these ships do not carry one type of cargo. In addition, each ship ranges in the number of TEUs it can carry ranging from a few on the smallest to 15,000 thousand on the largest. Only two percent of this cargo gets physically inspected; the remainder is scanned via machine.

The scenario is based on a Post Panamax ship sinking at the mouth of the channel leading into New York harbor and the implications. A ship of this size would block the channel and disrupt the flow of goods into the port. The sinking of the ship is the result of a deliberate act to block the channel.

The economic affects would be felt due to the channel being blocked and the harbor being closed. This would be felt nationwide. At a local level, the city of New York would lose over five million in tax revenue per day as well 32 million in lost wages each day. The would mostly affect the northeast most but would still significantly impact the

rest of the coastal states from Maine to Texas. These states would need to absorb the extra shipping. The Department of State is one of the agencies that would have to be involved and work with neighboring Canada and Mexico to arrange for the overflow of shipping to pull into their ports and transfer the cargo back to the United States.

The United States has the dredging equipment available should the need arise to dredge a new channel around a ship that is blocking a channel. It is simply a matter of cost and time. The cost would be less than leaving the channel blocked. The salvage aspect of this is a different matter. The United States does not have a lot of heavy lift salvage equipment at its disposal. The bulk of the equipment belongs to private international corporations. These corporations use this equipment on oil platforms and the stations that support the platforms. The cost of breaking the oil contracts for the salvage companies has very stiff penalties.

Some of the findings were unexpected, such as the Navy being the lead agency for Salvage operations. This was shocking because as a naval officer I knew what the Navy's salvage capabilities were and that the Navy does not have any equipment to conduct such a large salvage operation, but can contract out the job to other departments or private industry in accordance with the Salvage Facilities Act. Another surprise was the outcome of using a LNG tanker as a floating bomb. It was always believed that those ships are a perfect target for extremist organizations. What better way to cause mass devastation to an area?

A topic for further research is the capabilities that can be used to combat this possible threat. What procedure and protocols does the United States have in place to combat this threat? If an extremist organization is able to transport chemical or biological

weapons in one of these containers, how will it be detected? Do we rely on the inspection teams where the cargo originated or possibly use the intelligence community to detect and track this threat, and intercept a terror threat before it gets to the United States? Do all ports in the United States have the procedures and protocols for inspecting cargo that enters the country? Alternatively, is it just the major ports that have the equipment and personnel to inspect the goods that are entering and exiting the country?

In closing, New York Harbor and its ports are strategic assets to the United States. The harbor and the ports are a major source of income for the region. Each year hundreds of billions of dollars in goods are imported and export through New York harbor. If the channel is blocked and the harbor is shut down, it would prove disastrous for the east coast.

BIBLIOGRAPHY

Books

- The 9/11 Commission Report: Final Report of the National Commission on Terrorist Attacks Upon the United States*. New York: W.W. Norton, 2004.
- Bedford, Tim. and Roger Cooke. *Probabilistic Risk Analysis: Foundations and Methods*. Cambridge, UK: Cambridge University Press, 2001.
- Chenand, Andrew H. and Thomas F. Siems. "The Effects of Terrorism on Global Capital Markets." In *The Economic Analysis of Terrorism*, edited by Tilman Bruck, 86-206. New York, NY: Routledge, 2007.
- Douglass, James. "Police National Maritime Security Strategy." In *Harbour Protection through Data Fusion Technologies*, edited by Elisa Shahbazian, Galina Rogova, and Michael J. Deweert. 33-36. Berlin, Germany: Springer, 2009.
- Hora, Steven "Eliciting Probabilities from Experts." In *Advances in Decision Analysis*, edited by Ward Edwards, Ralph F. Miles, and Detlof von Winterfeldt, 129-153. Cambridge, MA: Cambridge University Press, 2007.
- International Maritime Organization. *International Ship and Port Facility Security (ISPS)*. London, UK: Albert Embankment, 2012.
- Libicki, Martin C., Peter Chalk, and Melanie Sisson. *Exploring Terrorist Targeting Preferences*. Santa Monica, CA: Rand Corporation, 2007.
- Treyz, George I. *Regional Economic Modeling; A Systematic Approach to Economic Forecasting and Policy Analysis*. Boston, MA: Kluwer Academic Publishers, 1993.
- Weick, Karl E., and Kathleen M. Sutcliffe. *Managing the Unexpected: Assuring High Performance in an Age of Complexity*. San Francisco, CA: Jossey-Bass, 2001.

Government Documents

- Committee on Assessing the Costs of Natural Disasters, National Research Council. *The Impacts of Natural Disasters: A Framework for Loss Estimation*. Washington, DC: National Academy Press, 1999.
- Committee on Remedial Action Priorities for Hazardous Waste Sites, National Research Council. *Ranking Hazardous Waste Sites for Remedial Action*. Washington, DC: National Academy Press, 1994.

- Government Accountability Office. GAO-02-1090T, *Marine Transportation, Federal Financing and Infrastructure Investment Framework*. Washington, DC: Government Accountability Office, September 2002.
- . GAO-04-890, *Transportation Security R&D: TSA and DHS Are Researching and Developing Technologies, but Need to Improve R&D Management*. Washington, DC: Government Accountability Office, 2004.
- . GAO-09-188R, *Natural Hazard Mitigation Insurance: The United States and Selected Countries Have Similar Natural Hazard Mitigation Policies but Different Insurance Approaches*. Washington, DC: Government Accountability Office, 2008.
- . *Maritime Security: Public Safety Consequences of a Terrorist Attack on a Tanker Carrying Liquefied Natural Gas Need Clarification*. Washington, DC: Government Accountability Office, February 2007.
- Hecker, Jayetta Z. GAO-02-993T, *Port Security: Nation Faces Formidable Challenges In Making New Initiatives Successful*. Washington, DC: Government Accountability Office, 2002.
- President of the United States. National Security Presidential Directive NSPD-41, and Homeland Security Presidential Directive HSPD-13, Memorandum, *Maritime Security Policy*. December 21, 2004. <https://www.fas.org/irp/offdocs/nspd/> (accessed 12 December 2013).
- Stana, Richard. GAO-05-466T, *Homeland Security: Key Cargo Security Programs Can Be Improved*. Washington, DC: Government Accountability Office, 2005.
- U.S. Congress. Report of the Committee for Marine Salvage Response Capability: A Workshop, Conference Proceedings. *Marine Salvage Capabilities Responding to Terrorist Attacks in U.S. Ports-Actions to Improve Readiness for Transportation Research Board*. Washington, DC, 5-6 August 2003.
- . Senate. Joint Economic Committee. *Potential Economic Impacts of Hurricane Katrina*. 2005.
- U.S. Nuclear Regulatory Commission. Report NUREG-1150, *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants*. Washington, DC: Nuclear Regulatory Commission, 1990.
- . SECY-98-144, *White Paper on Risk-Informed and Performance-Based Regulation*. Washington, DC: Nuclear Regulatory Commission. 24 February 1999.

Internet Sources

- AG Times. "CBP Fact Sheet: The 5 Percent Myth vs. U.S. Customs and Border Protection Reality." 7 October 2004. <http://agtimes.com/boards/viewtopic.php?t=32630&sid=e136dc9bb0c4548451a11a1d4e44bec8> (accessed 2 August 2013).
- The American Waterways Operators. "Ship Capacity vs. Other Means." <http://www.americanwaterways.com/initiatives/jobs-economy/industry-facts> (accessed 19 August 2013).
- Anderson Economic Group. "Flash Estimate Impact of West Coast Port Shutdown." www.andersoneconomicgroup.com (accessed 16 August 2013).
- Blanche, Ed. "Tanker Terror: Gulf's Oil Routes Under Threat." Jihad Watch, 22 April 2004. <http://www.jihadwatch.org/archives/001677.php> (accessed 26 April 2007).
- Bloomberg. "7 Dead after Oil Tanker Explodes." GCaptain, 12 October 2013. <http://gcaptain.com/dead-tanker-explodes/> (accessed 21 September 2013).
- Business Wire. "West Coast Port Shutdowns are a Major Economic Security Issue Says CEA." 2002. http://findarticles.com/p/articles/mi_m0EIN/is_/ai_92425853. (accessed 16 August 2013).
- California Energy Commission. "Liquefied Natural Gas (LNG) as a Transportation Fuel." www.consumerenergycenter.org/transportation/afvs/LNG (accessed 12 May 2013).
- Chertoff, Michael. "A Fresh Look at Port Security." *Leadership Journal* (February 2008). www.dhs.gov/journal/leadership/2008/02/fresh-look-at-port-security.html. (accessed 29 October 2013).
- Combating Terrorism Technical Support Working Group. "TSWG Description." <http://www.tswg.gov/tswg/about/about.htm> (accessed 20 October 2007).
- Cornell University Law School. 10 USC , §7361-7364, Chapter 637, *Salvage Facilities Act*. <http://www.law.cornell.edu/uscode/text/10/subtitle-C/part-IV/chapter-637> (accessed 17 August 2013).
- . 19 CFR, *U.S. Customs And Border Protection, Department Of Homeland Security; Department Of The Treasury*, October 2002. <http://www.law.cornell.edu/cfr/text/19/chapter-I> (accessed 12 May 2013).
- Davey, Michael, Christine M. Matthews, John D. Moteff, Daniel Morgan, Robert Esworthy, Wendy H. Schacht, Pamela Smith, and Wayne Morrissey. Congressional Research Report for Congress, *Federal Research and Development*

- Funding: FY2008*. September 2007. <http://www.fas.org/sgp/crs/misc/RL34048.pdf> (accessed 21 September 2013).
- Department of Commerce. National Oceanic Data Center. “Water Temperature Table of the Central Atlantic Coast.” <http://www.nodc.noaa.gov/dsdt/cwtg/catl.html> (accessed 10 August 2013).
- Department of Homeland Security. *Science and Technology Strategy*. Washington, DC: Government Printing Office, June 2007. http://www.dhs.gov/xlibrary/assets/Science_and_Technology_Strategy.pdf (accessed 10 October 2013).
- . *Strategy to Enhance International Supply Chain Security*. Washington, DC: Government Printing Office, July 2007. <http://www.dhs.gov/xlibrary/assets/plcy-internationalsupplychainsecuritystrategy.pdf> (accessed 16 October 2013).
- Department of Homeland Security, Office of Science and Technology Policy, Science and Technology Directorate. *The National Plan for Research and Development in Support of Critical Infrastructure Protection*. 2004. http://www.dhs.gov/xlibrary/assets/ST_2004_NCIP_RD_PlanFINALApr05.pdf (accessed 18 September 2013).
- Department of Transportation. Bureau of Transportation Bureau Fact Sheets, “Atlantic Port Call by Tonnage 2009.” http://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/bts_fact_sheets/october_2010/html/figure_04.html (accessed 28 August 2013).
- Department of Transportation, Maritime Administration. *Vessel Calls at U.S. Ports, 2003*. July 2004. <https://www.hsdl.org/?view&did=455399> (accessed 21 September 2013).
- Energy Information Administration. “New York/New Jersey Intra Harbor Petroleum Supplies Following Hurricane Sandy: Summary of Impacts Through November 13, 2012.” http://www.eia.gov/special/disruptions/hurricane/sandy/petroleum_terminal_survey.cfm (accessed 11 September 2013).
- Environmental Protection Agency. “Exxon Valdez.” <http://www.epa.gov/oem/content/learning/exxon.htm> (accessed 7 May 2013).
- Federal Emergency Management Agency. *HAZUS Annual Progress and Utilization Report for Fiscal Year 2004*. http://www.fema.gov/media-library-data/20130726-1744-25045-8327/dl_hazus04.pdf (accessed 16 February 2006).
- . *SW Florida HAZUS-MH Pilot Project, 2004*. <https://www.hsdl.org/?view&did=458333> (accessed 1 February 2013).
- Fritelli, John F. *Port and Maritime Security: Background and Issues for Congress*. 27 May 2005. <https://www.fas.org/sgp/crs/homesec/RL31733.pdf> (accessed 4 August 2013).

- Frittelli, John F., Martin R. Lee, Jonathan Medalia, Ronald O'Rourke, and Raphael Perl. *Maritime Security: Background and Issues*. Nova Science Publishers, 2003.
- Gibbs, Linda I., Co-Chair, and Deputy Mayor Caswell F. Holloway, Co-Chair. *Hurricane Sandy After Action*. Report and Recommendations to Mayor Michael R. Bloomberg, May 2013. http://www.nyc.gov/html/recovery/downloads/pdf/sandy_aar_5.2.13.pdf (accessed 21 June 2013).
- Government Accountability Office. GAO-07-316, *Maritime Security Public Safety Consequences of a Terrorist Attack on a LNG*. Washington, DC: Government Accountability Office, February 2007. <http://www.gao.gov/new.items/d07316.pdf> (accessed 1 February 2007).
- . *Hurricane Katrina—GAO's Preliminary Observations Regarding Preparedness, Response, and Recovery*. Testimony before the Senate Homeland Security and Governmental Affairs Committee. Washington, DC: Government Accountability Office, 2006. <http://webcache.googleusercontent.com/search?q=cache:zWqfORcSOyUJ:www.gao.gov/new.items/d06442t.pdf+&cd=1&hl=en&ct=clnk&gl=us> (accessed 8 December 2013).
- Homeland Security Digital Library. "DHS Announces \$445 Million to Secure Critical Infrastructure." January 2007. <https://www.hsd1.org/blog/post/view/2140> (accessed 16 December 2013).
- . Department of Homeland Security's Biological Risk Analysis: A Call for Change." 2008. www.dhs.gov/xlibrary/assets/TechnicalReview-NRCreport_Final_v2.pdf (accessed 12 May 2013).
- . *The Maritime Infrastructure Recovery Plan For The National Strategy For Maritime Security*. April 2006. <http://www.hsd1.org/?view&did=462514> (accessed 2 June 2013).
- International Group of Liquefied Natural Gas Importers. "The LNG Industry." 2011. <http://www.giignl.org/> (accessed 3 March 2013).
- International Maritime Organization. "FAQ on ISPS Code and Maritime Security." 2002. <http://www.imo.org/> (accessed 20 September 2013).
- . "International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW)." [http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-on-Standards-of-Training,-Certification-and-Watchkeeping-for-Seafarers-\(STCW\).aspx](http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-on-Standards-of-Training,-Certification-and-Watchkeeping-for-Seafarers-(STCW).aspx) (accessed 17 August 2013).
- International Mobile Satellite Organization. "Global Maritime and Safety Distress Systems." <http://www.imsso.org/GMDSS.asp> (accessed 21 October 2013).

- Internet Archive Wayback Machine. "History: Exxon Valdez Oil Spill Trustee Council." <http://web.archive.org/web/20070630224835/www.evostc.state.ak.us/History/FAQ.cfm> (16 (accessed 12 August 2013).
- Lamrock, Rory, AKE Security. "LNG-specific piracy risks: Myths and realities." *Energy Global*. 25 November 2011. http://www.energyglobal.com/news/drilling-and-production/articles/LNG-specific_piracy_risks_myths_and_realities.aspx#UgUppD0o7IU (accessed 20 August 2013).
- Leach, Peter T. "Port of NY-NJ Containers Jumped 16 Percent in 2010." *Journal of Commerce*, 3 March 2011. https://www.joc.com/maritime-news/port-ny-nj-containers-jumped-16-percent-2010_20110303.html (accessed 15 October 2013).
- Marburger, John, and Steven McMillin. "Memorandum for the Heads of Executive Departments and Agencies." Office of Science and Technology Policy, 14 August 2007. <http://www.ostp.gov/html/FY2009FINALOMB-OSTPRDPriorityMemo.pdf> (accessed 20 October 2013).
- Marine Connector. "Ship Sizes." <http://maritime-connector.com/wiki/ship-sizes/> (accessed 11 June 2013).
- The Maritime Executive. "Resolve To Remove MV Rena Wreck from Astrolabe Reef." 3 August 2012. <http://www.maritime-executive.com/article/resolve-to-remove-mv-rena-wreck-from-astrolabe-reef/> (accessed 21 June 2013).
- Monterey Bay Aquarium Research Institute. "MBARI teams with Monterey Bay National Marine Sanctuary to study effects of shipping containers lost at sea." 7 March 2011. http://www.mbari.org/news/news_releases/2011/containers/containers-release.html (accessed 11 September 2013).
- Moss Maritime. "LNG Tanker Design." <http://www.mossww.com/technologies.php> (accessed 23 June 2013).
- National Climatic Data Center. "Billion-Dollar Weather/Climate Disasters." <http://www.ncdc.noaa.gov/billions/> (accessed 13 June 2013).
- National Oceanic and Atmosphere Association. "NOAA Chart 12327." <http://www.charts.noaa.gov/OnLineViewer/12327.shtml> (accessed 11 October 2013).
- New York City Office of Emergency Management. "New York City Hazards: New York City Hurricane History." http://www.nyc.gov/html/oem/html/hazards/storms_hurricanehistory.shtml (accessed 21 September 2013).
- "North America LNG Import Terminals." *Natural Gas Intelligence*, March 2006. <http://intelligencepress.com/features/lng/> (accessed 6 March 2007).

- Parfomak, Paul, and John Frittelli. *Maritime Security: Potential Attacks and Protection Priorities*. Congressional Research Service Report for Congress, 2007. <http://www.fas.org/sgp/crs/homsec/RL33787.pdf> (accessed 21 September 2007).
- Podsada, Janice. "Lost Sea Cargo: Beach Bounty or Junk?" *National Geographic*, 19 June 2001. http://news.nationalgeographic.com/news/2001/06/0619_seacargo.html (accessed 8 July 2013).
- The Port Authority of New York and New Jersey. "2012 Trade Stats Sheet." <http://www.panynj.gov/port/trade-stats.html> (accessed 22 July 2013).
- . "Harbor-Deepening." <http://www.panynj.gov/port/harbor-deepening.html> (accessed 10 August 2013.).
- . "About the Port." <http://www.panynj.gov/port/about-port.html> (accessed 11 June 2013).
- "Serious LNG Crew Shortage Looms." *Oil and Gas Journal*, 4 April 2005. http://www.ogj.com/display_article/224811/94/ARCHI/none/none/Qatar,-India,-Egypt-advance-plans;-US-gulfterminals-break-ground/ (accessed 13 May 2007).
- Thompson, Brian. "Oil Spill Fears in New York Harbor: They're Real." *NBC News*, 20 September 2010. <http://www.nbcnewyork.com/news/local/Oil-Spill-Fears-in-New-York-Harbor-Theyre-Real-103298494.html> (accessed 6 August 2013).
- Trading Economics. "United States GDP." <http://www.tradingeconomics.com/united-states/gdp> (accessed 21 August 2013).
- United Nations Conference on Trade and Development. *Review of Maritime Transport 2006*. (New York: United Nations, 2006). http://unctad.org/en/docs/rmt2006_en.pdf (accessed 8 August 2013).
- U.S. Coast Guard. "Merchant Vessel Inspection and Documentation" <http://www.uscg.mil/international/affairs/Publications/MMSCode/english/Chap13.htm> (accessed 7 May 2013).
- . "Port Security." 2008. www.uscg.mil/news/cgnews.shtm (accessed 29 October 2013).
- USA Trade Online. "Annual Port-level Imports and Exports." U.S. Census Bureau. <http://www.usatradeonline.gov/> (accessed 28 August 2013).
- The White House. *The National Strategy for Maritime Security*. September 2005. <http://www.whitehouse.gov/homeland/4844-nsms.pdf> (accessed 18 September 2013).

Wikipedia Encyclopedia. "List of World's Longest Ships." http://en.wikipedia.org/wiki/List_of_world's_longest_ships (accessed 16 August 2013).

Journals/Periodicals

- Aven, Terje, and Ortwin Renn. "The Role of Quantitative Risk Assessment for Characterizing Risk and Uncertainty and Delineating Appropriate Risk Management Options, Special Emphasis on Terrorism Risk." *Risk Analysis* 29, no. 4 (December 2008): 587-599.
- Brody, S., W. Highland, S. Bernhardt, A. Vedlitz, and S. Zahran. "Policy Learning for Flood Mitigation: A Longitudinal Assessment of the Community Rating System in Florida." *Risk Analysis* 29, no. 6 (29 January 2009): 912-929.
- Bureau of National Affairs. "Daily Report for Executives." no. 75, 18 April 2003.
- Greenberg, Michael, Michael Lahr, and Nancy Mantell. "Understanding the Economic Costs and Benefits of Catastrophes and Their Aftermath: A Review and Suggestions for the U.S. Federal Government." *Risk Analysis* 27, no. 1 (February 2007): 83-96.
- Greenberg, Michael, Nancy Mantell, Michael Lahr, and Frank. Felder. "Short and Intermediate Impact to New Jersey's Economy of the Loss of Electric Power in New Jersey's Urban Industrial Corridor." *Energy Policy*, 135 (25 November 2007): 722-33.
- Haimes, Yacov, Barry Horowitz, James Lambert, Joost Santos, Chenyang Lian, and Kenneth Crowther. "Inoperability Input-Output Model for Interdependent Infrastructure Sectors. 1: Theory and Methodology." *Journal of Infrastructure Systems* 11, no. 2 (1 June 2005): 67-79.
- Jung, Jeesang, Joost Santos, and Yacov Haimes. "International Trade Inoperability Input-Output Model (IT-IIM): Theory and Application." *Risk Analysis* 29, no. 1 (September 2008): 137-154.
- Kunreuther, Howard. "Mitigating Disaster Losses through Insurance." *Journal of Risk and Uncertainty* 12, no. 2-3 (June 1996): 171-187.
- Miller, Tyler, David Lewis, Michael Frisch, and Michael Greenberg. Innovative Worker Separation, Severance Policies, And Economic Migration At U.S. Department Of Energy Sites. *Applied Research in Economic Development* 2, no. 1 (July 2007): 3-16.
- Willis, Henry. "Guiding Resource Allocations Based Terrorism Risk." *Risk Analysis* 27, no. 3 (March 2006): 597-606.

Other Sources

- Burton, Mark L. and Michael Hicks. "Hurricane Katrina: Preliminary Estimates of Commercial and Public Sector Damages." Huntington: Center for Business and Economic Research, Marshall University, Huntington, WV, September 2005.
- Carafano, James and Alane Kochems. Heritage Special Report SR-03, "Making the Sea Safer: A National Agenda for Maritime Security and Counterterrorism." The Heritage Foundation, Washington, DC, 2005.
- Heinz Center for Science, Economics and the Environment. *The Hidden Costs of Coastal Hazards: Implications for Risk Assessment and Mitigation*. Washington, DC: Island Press, 2002.
- Hurst, Cindy, LCDR. "The Terrorist Threat to Liquefied Natural Gas: Fact or Fiction." Institute for the Analysis of Global Security, Washington, DC, February 2008.
- Rose, Adam, Gbadebo Oladosu, and Shu-Yi Liao. "Regional Economic Impacts of Terrorist Attacks on the Electric Power System of Los Angeles: A Computable General Disequilibrium Analysis." Paper presented at the Second Annual Symposium of the Department of Homeland Security Center for Risk and Economic Analysis of Terrorism, University of Southern California, Los Angeles, CA, 20 August 2005.